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Engineering News-Record

How to Lay Out An Airplane Landing Field

By Archibald Black

Other Articles for the Municipal Engineer

Street Cleaning Methods and Costs at Akron, O.; By F. C. Tolles

Cleveland's Westerly and Easterly Sewage Works; By G. B. Gascogine

Some Municipal Developments in Pueblo and Denver

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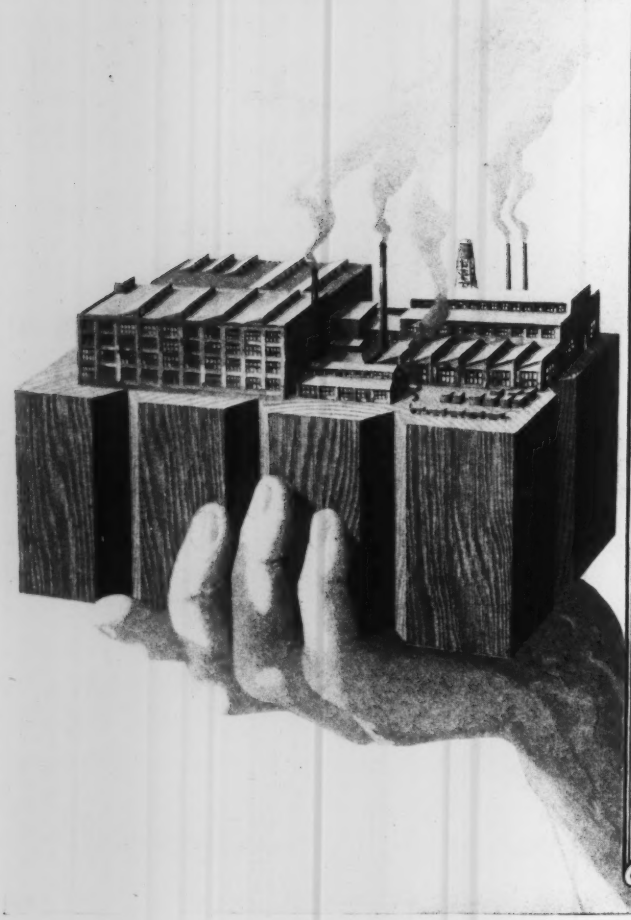

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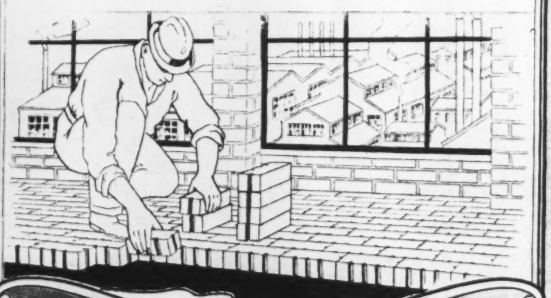

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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Cleveland's New Sewage-Works

NOT least among the municipal improvements that many of those attending the convention of the American Society of Municipal Improvements at Cleveland next week will desire to visit are the two sewage-works recently put in operation there. These works, the nature and extent of which are outlined elsewhere in this issue, go far towards completing one of the largest programs of sewage treatment ever yet adopted by an American city. Imhoff tanks were chosen following lengthy experiments with various processes and despite strenuous efforts by promoters to substitute fine screens although those in responsible charge of the experiments had concluded after a small working-scale test that they would not meet local requirements. All this, combined with severe criticisms of the Imhoff tank in some quarters for years past, and its disfavor after extensive use at Baltimore, should add to the interest of a visit to the Cleveland sewage-works.

An Explanation Wanted

AN OCCURRENCE like the Strand theater floor collapse last Friday places the community which permits it to happen in a decidedly unfavorable light. It is the business of the public authorities to prevent such accidents, to make impossible a piece of inexcusable construction like building decayed wood into a structure intended for public use. And it is the community's business to maintain a spirit that will induce its officials to carry out their obligations. Pittsburgh has some genuine explaining to do in the Strand theater case, the more so as only a few months ago the city had another theater accident which revealed equally bad conditions. Pittsburghers may claim that the occurrence of two accidents is mere coincidence, and that either accident, or both, might have happened elsewhere. True. But it is also true that when the practice of bad building gets a start in a particular city it easily becomes a habit. The habit appears to have taken hold in Pittsburgh. It may be general, or it may be confined to the moving picture "industry." If the latter proves to be the case it may be practicable to reduce the danger by requiring that every moving picture theater owner furnish heavy bonds against accident. There is no reason why moving picture theaters should continue to be less safe than other public buildings.

An Asphalt-Paving Experiment

CHANGES in asphalt-paving specifications have for a long time concerned themselves chiefly with the control of the mixture to reduce shoving and to carry the loads of modern motor trucks. In the light of this fact the new pavement being built in Philadelphia, as described elsewhere in this issue, is of radical design. The departures from previous practice are essentially structural. First, the bond between surface and base is made definitely rough and more pronouncedly rough than any raking or corrugating of the concrete, as in ordinary practice, is able to make it. Second, the surface has been made mechanically rigid by thickening the binder and using large size stone up to dimensions equaling the full depth of the binder. The coarse stone, it is thought, will interlock and make the binder course, considered as a column, more rigid against lateral forces, while the roughened base will prevent sliding on the bonding plane. It may be anticipated that both the necessity and the special efficiency of these structural precautions against shoving will be questioned. Several seasons of service will be required to disclose positive evidence. At the least estimate, however, the experiment is in the line of constructive thinking and offers enough possibilities to make careful observation of decided interest.

Zoning Progress

THE rapid progress of city zoning is not fully shown by the mere statement that in the past six years eighty cities have adopted the system. There must be taken into account the fact that at the outset the average city father did not even know what zoning was, much less understand its value. Then, too, in many if not most states legislation was necessary, and in practically all highly desirable, before their cities could legally adopt zoning; while in others constitutional amendments seemed imperative. The list compiled by Miss Voorhees, of the United States Department of Commerce, shows that at least seventy-eight cities, in sixteen states and the District of Columbia, have adopted zoning. That there is considerable lag in the use of the zoning powers thus far granted appears from the fact that although twenty-five states have authorized some degree of zoning, the power has been exercised as yet in but sixteen, and in some of these by only one or a very few cities. This is due partly to the newness of the enabling legislation, and partly to the restriction of zoning powers in a third of the twenty-five states to one or a few cities. In three states where the grant is of general application, forty-six cities, or more than half in the whole list, have adopted zoning: New Jersey, twenty-two; California, thirteen; New York, eleven. The zoning activity of the present year has been even more notable than appears from the cases thus far listed, because: (1) There remain several months for action in 1922; (2) probably not all adoptions this year have yet been reported; (3) there is much zoning work in progress that will not be consummated until 1923. Further impetus doubtless will be given to zoning by new enabling acts to be passed next year, when most of the state legislatures will be in session. Material aid to such legislation has been provided by the Department of Commerce, which has drafted a model zoning act. The same government agency has also made available to all concerned a Zoning Primer.

The Lima Sewage Deadlock

A FEATURE of the Am. Soc. M. I. program at Cleveland next week is a review of the present status of sewage treatment by George W. Fuller, which has been included in the advance copies of papers circulated by the society to promote discussion at the convention. It would be out of place to discuss Mr. Fuller's paper here, but the object of printing papers in advance may properly be promoted by calling attention to a somewhat extended statement by Mr. Fuller of what has been at least a temporary deadlock on the sewage-works of Lima, Ohio, where Mr. Fuller's plans for fine screens and sprinkling filters, after having been approved by the Ohio State Department of Health, and sent out to bidders were withdrawn by the city authorities in order to give a chance for the reception of alternate bids for the Landreth direct-oxidation process. That was late in March of this year. The proposed alternative bids were never invited, but plans for the Landreth process were submitted to the State Department of Health for approval. The department requested information as to the Landreth process and its efficiency and the Lima authorities engaged Col. George A. Johnson to supply it. His report was favorable to the process but at last accounts the department had not rendered its decision on the Lima application. Mr. Fuller's review of this situation, combined with a paper by the city engineer of Allentown, Pa., on the operation of the Landreth plant in that city, gives promise of lively discussion at the Cleveland convention.

New Work for City Engineers

MUNICIPAL engineering is commonly understood to include certain definite kinds of work in which there has been little change for a generation or more. The city engineer, up to the present, has had to deal with four main specialties: paving, water supply, sewerage and refuse disposal. It is possible that developments of the twentieth century may enlarge the scope of his duties. Ample evidence is on hand to indicate that the growth of motor traffic has given rise to new problems demanding a very large share of his attention. But what of traffic by air routes? It is not a rash prediction to say that before many years have passed every city or town of any importance will have to have its airplane landing and take-off fields. The article on this subject by Archibald Black (see p. 504) is apropos. In a few cities engineers have been called upon to design and lay out an airplane field, but for the most part this is a branch of engineering which, on account of the comparative newness of air travel, has received little attention. At almost any time a city engineer may be called upon for advice as to the proper type of runways for airplane landings, suitable schemes of field marking, arrangement of buildings, the most desirable size and shape of plots, and similar queries for which it is difficult to find answers in technical literature now available. The municipal engineer who would be up-to-date needs to know something about airplane landing fields. Mr. Black's article has some interesting information for him on this subject.

Sweeping-Machine Performance

RECORDS of performance of street-sweeping machines, particularly when comparisons are drawn between different types or makes of sweepers, must be carefully analyzed before general conclusions are asserted. On a street having a smooth pavement and a high crown, with a greatly predominating fast automobile traffic, the sweeping conditions are quite different from those on streets having the opposite characteristics. The volume of dirt moved may not differ greatly but its distribution is entirely dissimilar. On smooth pavements with high crowns the fast traveling cars sweep the dry dirt toward the gutters. Commonly in such a street the sweeping machines do not need to touch the middle of the roadway and a trip up one side and down the other cleans the pavement. Always in computing yardage, however, the full width of the street must be counted. When the whole street is covered the yardage is no greater, on the records, than when only the sides are covered, but the machines are required to make from 50 to 100 per cent more mileage. A comparison on a yardage basis favors the machine which makes the smaller mileage although it may not be a whit more effective or more efficiently operated than the other. When the sweepers are employed interchangeably, sometimes in one territory and sometimes in another, the average performances indicate comparative efficiency quite fairly but the fact may be altogether different where there is a territorial assignment of machines. These facts account for a great many of the apparent discrepancies in sweeper performance records from different cities or from different street cleaning districts of the same city.

Too Many Asphalt Grades

ARE highway engineers insisting upon too great refinement in their specifications for asphalt for road work? A review of the requirements of a number of state highway departments indicate wide variations in the most important test for asphalt quality, namely, penetration. It is true that for certain special conditions of traffic or climate special grades of asphalt may be necessary, but according to the views of asphalt producing interests, as expressed in the section, "From the Manufacturer's Point of View," of this issue, there is opportunity for constructive work in eliminating the number of asphalt varieties called for without lowering the quality of any of the types of construction in which asphalt is used.

It is maintained that, for all practical purposes, an upper limit of seven grades of material is ample, as against thirty or more which are now demanded in the specifications which highway engineers have issued in the various states. The plea for fewer grades of asphalt comes from the producer. Have highway engineers anything to say in defense of their position? *Engineering News-Record* will welcome discussion on this important subject.

There is no doubt that on account of the highly technical character of the chemistry of asphalt, many engineers have adopted specifications more or less blindly merely because they have been used by someone else. Still others, with adequate laboratory equipment and chemical personnel, lean the other way by putting into their specifications a great amount of individualism. Apparently few of them have given much thought to the troubles which demands for so many varieties of asphalt pile upon the shoulders of the producer.

The matter of reduction in varieties in construction materials is now new. Only this year the paving brick

industry took decisive action in reducing the varieties of paving brick from 66 to 11. Cement specifications have long since been standardized, and we do not find every engineer with a concrete dam or a factory to build putting into his specifications various and sundry special tests for cement. What has happened in the case of brick and cement indicates that some benefits may be derived from an impartial inquiry into present practices of specifying asphalt. There is no doubt that under the present system there is a great economic loss. With fewer and more uniform requirements—but with enough to insure a sound quality of material—the producer's problem would be vastly simplified and lower production costs made possible.

Consulting Advice by Questionnaire

EVERY city engineer, water-works superintendent or other technical official knows what a nuisance the average questionnaire has come to be. Often it is addressed to the mayor or other ranking official who passes it down the line little knowing the enormous amount of work it may entail. His word is law, and valuable time must be spent to satisfy the questionnaire fiend who more often than not asks for a lot of information, opinions and advice that would require several weeks of investigation by a consulting engineer.

A most flagrant case of this kind is the present attempt by some one who signs himself "F. Whitney" to get five or ten thousand dollars worth of advice on a water supply in Lake County, Illinois, presumably for Waukegan, by means of a set of questions sent to other Great Lakes communities. The survey, as he calls his questionnaire, contains more than 250 blank spaces to be filled out under sixteen heads. Every conceivable sort of question relating to a water supply from intake cost to chlorine application, from water rates to pumpage, from types of meters to pipe sizes, is asked on three single-spaced mimeographed sheets of foolscap size. The letter accompanying the request for information is naïve, to say the least. The last paragraph is a masterpiece of professional impudence or gross ignorance of the value of professional advice. It follows:

"In addition to the points raised by the survey questions and data, it would be a pleasure to get your mature practical views on what you deem ideal for Great Lakes communities and also what your experience has rubbed into you in regard to your pumps, boilers, steel vs. cast-iron pipe in Great Lakes' soils and waters, and especially on the relative merits of filtration and non-filtration by going to sufficient distances and depths to get reasonably safe water in its raw condition. Have you any views on tunnel intakes and submerged cribs, anchor ice, etc.? What is your view on tunnels?"

At least one city official received special attention in a typewritten request for additional information on tunnels involving some seventy items. "Practical views" on filtration versus long tunnels with chemical treatment were requested as well as preferences for brick or concrete as a tunnel lining and why.

The questionnaire, a legitimate means of collecting information, is in a fair way of being discredited by abuse. Since the war its use has been multiplied beyond reason so that every one is now looked on with suspicion. There is a limit to the obligation to answer such inquiries and in the engineering field that limit is pretty definitely marked where professional opinion is asked. Queries as to facts, when properly validated and within reasonable bounds, should be answered as a matter of professional courtesy but attempts to obtain consulting advice by the circular method should be refused and denounced.

Detail Design

SO MUCH is said and written about the engineering of large-scale operations, and about what some people are pleased to call the broader aspects of professional activity, that the part played by detail design is often in serious danger of being forgotten. We say "danger" advisedly, for upon details the larger part of the modern engineering art is built up. But the field of details receives only slight recognition in society programs and in technical literature generally. This, we submit, is unfortunate, and ultimately to the disadvantage of the whole profession.

A fairly extended experience in dealing with technical literature leads to the conviction that much of this condition is due to the men who are engaged in detail designing—to their retiring disposition, perhaps, or to their feeling that the problems which they work upon do not interest the majority of their professional brethren. The latter feeling is certainly unwarranted. Let an enginer come before the public with a worth-while study of almost any detail in the whole field of engineering, and he is met in nearly every instance by a most active and interested spirit on the part of his hearers. If details are neglected in professional discussions, it would appear to be chargeable more to the retiring disposition of detail designers than to any extraneous cause.

Curiously enough, the inadequate representation of detail problems in our discussions has its most immediate reaction on the work of the detail designers themselves. Excellence in detailing, as most engineers will recognize, is not entirely within the control of the individual designer, but is much interwoven with current custom in the particular branch of the art concerned. When good practice develops in a particular field it is not always, or perhaps not often, the product of increased knowledge or designing skill, but is due rather to increased popularity of good construction—which means good detail construction. The consuming fields which includes many engineers, comes to demand good detail construction when a particular branch of the art is in a well developed stage, while in an earlier period it is apt to be impossible to secure acceptance for soundly designed details, because of competition based on the prevailing standards of practice. A constant educational process is needed to bring thorough detailing to the front and to keep it there. If the detail designer would have his product, namely good details, receive proper valuation, he must bring his work into professional discussions and take the lead in developing the demand for excellence.

In this effort, the editors of *Engineering News-Record* are at all times glad to help. More discussion of design details is published in the pages of this journal, perhaps, than in any other place of discussion of engineers, yet it represents only a small part of the vast field of design and construction details involved in the civil engigeer's work. The problem of bringing about a fuller representation of detail design in our current technical literature is one that concerns the whole profession.

How to Lay Out and Build an Airplane Landing Field

Notes on Shape and Size of Plot, Runway Details, Type and Arrangement of Buildings, Drainage of Field, Best Kind of Grass and Proper Marking to Aid Pilots

By Archibald Black
Consulting Aeronautical Engineer, Garden City, N. Y.

With various municipalities throughout the country considering the establishment of airplane landing fields, the arrangement of them becomes a problem which the city engineer is likely to be called upon to solve. Owing to the newness of the airplane industry little attention has been given to the systematic arrangement of such fields. While the Air Service has some very fully equipped fields, these were constructed

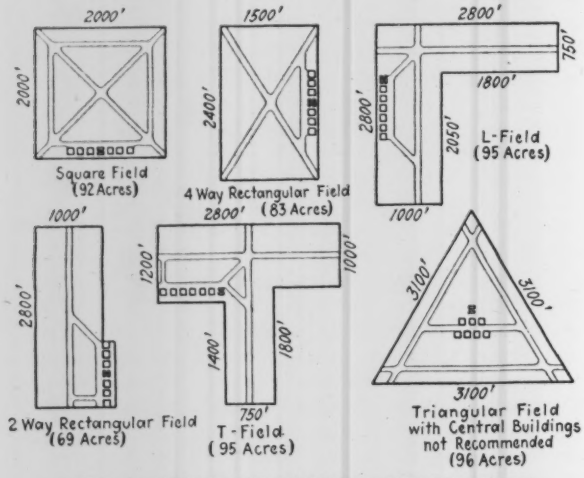


FIG. 1. TYPES OF LANDING FIELDS WITH 2,800-FT. RUNWAYS

Light lines indicate 2,800-ft. runways and most used connections.

under pressure of war conditions and at a time when the requirements of such fields were not fully understood. In addition to this, the army equipment is considerably more elaborate than is likely to become necessary at municipal fields for some time. Consequently, the city engineer charged with arranging a municipal field who attempts to copy the features of some army field, is likely to make as many errors as he avoids.

Shape and Size of Plot—In general, a square plot is the most suitable shape for a landing site, because it permits airplanes to take off or land in any direction. As the airplane must always take off and land headed into the wind, the importance of wind direction, and its effect upon the field layout, will be immediately appreciated. Where the direction of prevailing winds, throughout the year, is subjected to considerable variation, the square field is essential. In cases where less variation of wind direction is recorded, the plot may be narrowed until it becomes a comparatively narrow rectangle where little variation is shown. Before the property is purchased, Weather Bureau records should be consulted and this information obtained. It is one of the most important points for consideration in the arrangement of the field. In comparing the direction of the winds, their importance may be assumed to vary with the square of their velocity and directly as their frequency. Rough sketches of possible arrangements can then be made and the purchase of the plot negotiated intelligently.

The size of the plot will depend upon the useful length of the runways which can be provided. For the general run of airplanes and for low altitudes, say below 1,000 ft., a clear runway length of 2,500 to 3,000 ft. should be provided. This should be liberally increased for higher altitudes but the requirements regarding length of runways at altitudes are so dependent upon the types of machines that no general rules can be laid down. Thus, if the field is to be square, a 2,000 x 2,000-ft. plot will be required. If conditions permit, this size should be slightly increased. It is very undesirable to use a smaller plot, although it is possible to use one of about 1,800 x 1,800 ft. with slightly increased risk of accident. If the plot is to be L-shaped, the legs of the L should not be less than about 1,000 ft. wide, in addition to providing runway length. Where the field is surrounded by, or runways obstructed by, tall buildings, power lines, etc., the size must be increased. A good general rule is to assume that such obstructions render useless the adjacent part of the field, or territory around it, for a distance of 8 to 10 times their height. Fig. 1 shows a variety of different shapes of fields drawn to the same scale and each providing 2,800-ft. runways.

General Arrangement—In the general arrangement of any landing field provision should be made for hangars, shops, garages, field office, gasoline and oil storage, runways, roads, field marking, water, telephone, electric-power lines and, where necessary, field drainage. While many of these facilities will not be provided for some time, it is good policy to consider them all from the start. The plans should be prepared showing future as well as immediate installations. Only in this way can the field be expected to provide a logical arrangement when fully developed. The additional cost of this forethought and consideration is negligible, while neglect might prove expensive later. Fig. 2 shows what may be regarded as an ideal field layout using the square plot. This arrangement cannot be copied for any location; it must be adapted to the local conditions. Great consideration should be given to future expansion. The field, if laid out as indicated in Fig. 2, is so elastic in arrangement as to be capable of expansion to the limit of its capacity without moving any of the original buildings or equipment.

Buildings should be liberally spaced in order to reduce the fire hazard, which is usually serious at these fields. So much ground is necessary for runway purposes that there is nothing to be gained by crowding the buildings close together. All buildings should be on the side nearest to the road so that it is not necessary for automobiles or persons to cross the field to reach any of them. The arrangement shown provides for the field office and the miscellaneous buildings in the center of one side, with the hangars on each side, roadways and

railroad spur behind. This is probably the most convenient all-round arrangement but it may have to be modified to suit local conditions. No matter what arrangement may be used, great care should be taken to keep all structures, roads, etc., away from the ends of the runways.

Buildings—The hangars should be arranged, preferably facing the field, so that airplanes may be conveniently taken in or out. Where other considerations permit, these buildings should face south as this protects them somewhat from the cold north winds and makes conditions less uncomfortable for the mechanics in winter. In the case of the floors being of cinders, it also allows the sun to shine inside and keep this floor dry when the large door is open. The hangar layout should be sufficiently elastic to permit erection of several types of buildings without destroying the

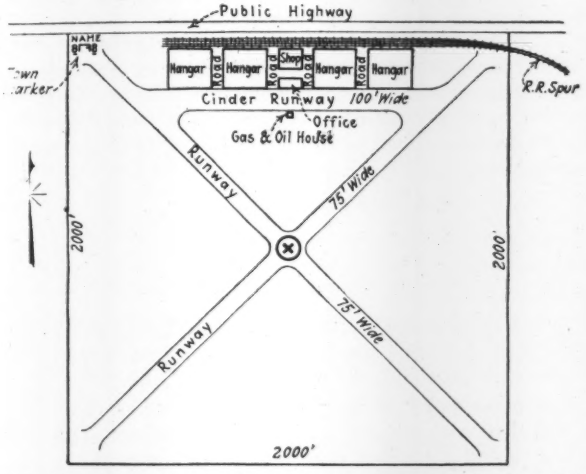


FIG. 2. IDEAL SQUARE FIELD FOR AIRPLANE LANDINGS

general arrangement. While the field may be provided with buildings of a certain size at the start, those added later may be very different in size and shape. If some effort is made to anticipate the possible variations in future buildings, much trouble may be avoided and the space utilized to better advantage as the side of the field becomes crowded with structures.

A study of all of the existing types and sizes of hangars on the American market showed that a 200 x 200-ft. plot appeared to accommodate itself better to the various arrangements than a smaller size. This plot also has the advantage of permitting the erection of an ultimate building of 200 x 200 ft. outside, should conditions ever warrant. As the largest airplane built to date has a span of only about 131 ft. this size of building should provide sufficiently for future machines. Fig. 3 shows some of the sizes and types of hangars which can be accommodated on the proposed "standard plot"; where space permits, its use is recommended. This same size of plot may be used for all of the other miscellaneous buildings as well as for hangars, unless local conditions necessitate otherwise. No rule can be formulated for the relation between hangar, garage and shop floor space as this will vary for each project. In most civil fields part of the hangars will probably be used for shop purposes at the start. The gasoline and oil house should be located well away from other buildings but convenient to both field and road so that either airplanes or automobiles may make use of its facilities. The field office building should be so placed that the field manager, pilots, or others who may have business there, can view the field, gasoline station, wind indicator, etc., from its windows. Such location will save considerable running around by these men when the field is in use.

Runways—In all cases the runways should be arranged with regard to both the direction of the higher prevailing winds and to the freedom from obstructions, either inside or outside of the field, at their ends. They should be as long as the size and shape of the field will permit, but arranged so that the pilot can take off directly into the wind as nearly as possible all of the time. They should also be arranged with some regard to the possibility of allowing space for a turn back into the field to effect a landing in case of engine failure while taking off. It will probably be found that the arrangement of two crossed runways comes nearest to providing this in most cases. Except where the soil drains very well, the part of each runway likely to be most used should be surfaced with cinders, slag or stone about 75 ft. wide for a distance of about 1,000 ft. The part of the runways likely to be most used will be that part on the end *towards* which the higher prevailing winds blow, excepting possibly 100 ft. at the extreme end. If funds limit the work, it might be well to consider that the surfacing of a strip less than 50 ft. wide and 750 ft. long is of very doubtful value. A track from the hangars to the surfaced part of the runways should also be surfaced. The width of this portion will vary according to conditions, but it would be well to provide a strip at least 25 ft. wide and located so that an airplane 100 to 150 ft. wide can be rolled along it without touching the buildings.

In the early days of aviation airplanes took off from and landed upon any convenient part of the field, using the grass-covered surface as a runway. Grass never was entirely satisfactory for this purpose. It held the soil together only when the traffic was infrequent and even then the ground softened up at certain periods of the year. As the business develops, the use of prepared runways is becoming accepted as necessary. Such runways must be constructed to carry the load of the airplane during its run over the surface before taking off and after landing. They must also resist damage to their surface when landings are effected thereon, this being probably the severest requirement. Table I gives some sizes of airplane tires with the loads which they may be normally expected to carry and impose upon the runway surface when at rest or moving slowly. The tendency in commercial and other machines today is towards lighter loadings of the tires. With good runways, this may revert back to the full loads of the table.

TABLE I—SOME AIRPLANE TIRE SIZES WITH THEIR NORMAL LOADS

Size of tire, in.	Normal load, lb.
26 x 3	325
26 x 4	750
26 x 5	1,000
32 x 6	1,650
36 x 8	3,100
44 x 10	6,000

The actual load at the moment of landing depends so much upon the machine and the pilot that it is impossible to give it any definite value. It may be less than the figures above, but is more likely to be greater. Landing gear stress calculations are usually based upon

an arbitrary weight of 4 to 6 times the weight of the airplane. It is very improbable, however, that loads even approaching this will be imposed upon the runway surface.

The types of surface most suitable for roads are not generally suitable for runways. The runway surface must not be so soft that the wheels sink into it or the take-off run will be seriously affected. On the other hand, it must not be too smooth and hard or the machines landing upon it will roll an excessive distance after landing. It has been found in practice that a good compromise surface can be obtained with cinders or slag, rolled just enough to remove the excessive looseness without solidly compacting the surface. Such a surface neither retards rolling too much nor too little, drains itself well and holds up under usage. As concrete has sometimes been proposed, and even used, for runways, it might be well to mention here that it is *not* suitable for this purpose unless separate runways

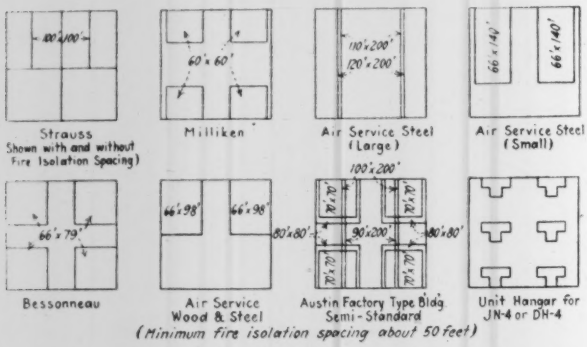

Strauss
Shown with and without Fire Isolation Spacing)
Milliken
Air Service Steel (Large)
Air Service Steel (Small)
Bessonneau
Air Service Wood & Steel
Austin Factory Type Bldg. Semi-Standard
Unit Hangar for JN-4 or DH-4
(Minimum fire isolation spacing about 50 feet)

FIG. 3. SOME POSSIBLE HANGAR ARRANGEMENTS IN "STANDARD" 200 x 200-FT. PLOT

are provided for taking-off and landing. It provides an excellent surface for taking-off from, but is entirely unsuited to landing on because of its smoothness. The cost of concrete construction also is so high as to make it prohibitive on most projects.

The runways should be crowned as little as possible. If they are to be drained to each side it is suggested that the crown be about ½ in. to the foot of width. If drained by percolation, either with or without artificial drains, it may be possible to slightly decrease even this figure. *It is very important that no open ditches be located in the vicinity of the runways.* If ditches are necessary for drainage of runways, they should be filled to the level of the field with broken stone, gravel, or other available material. Very large stones should be used in filling the bottom of the ditches and the size should be gradually decreased to small sizes at the top. This will prevent the ditch from filling up with silt during rains. The sides of the runways must be free from shoulders or ridges, not even shallow gutters being permissible in connection with the drainage system. The preferable method of draining the runways is by percolation. Where the soil is porous (gravel, sand, etc.) this can be obtained by merely using a porous runway construction. Where the soil is not sufficiently porous to take care of drainage naturally, a system of drainage ditches, filled with broken stone or gravel, should be constructed below a porous runway and arranged to carry away precipitation.

If the extreme ends of the runways are graded to an appreciable rise, this will tend to decrease the danger of collision with the fence or running over the property line when an airplane takes off and is immediately forced to land through engine or other trouble. A rise in grade of this kind should not end precipitately, but should drop gradually to the fence line. Another method of decreasing danger of overrunning is to raise a dense growth of tall grass on the ends of the runway. Either of these methods or, what is probably still better, a combination of both, might be used to retard the progress of any airplane approaching the fence too closely. It is probable that the adoption of reversible propellers, in the near future, may render such precautions less necessary but it is always well to have them.

Grass—The infield itself should be well drained and, where natural drainage cannot be relied upon throughout the year, an artificial drainage system should be provided. On all parts of the field surface not covered by buildings, roads or runways a growth of tough, all-year grass should be raised to bind the surface. The type of grass required will vary according to the soil and it would be well to consult some reliable seedsmen familiar with its characteristics. Peter Henderson & Co., of New York, were consulted regarding the conditions to be met and made the following recommendations:

Use about even proportions of:

Canada Blue Grass	*Hard fescue
Fancy Kentucky Blue grass	*Sheeps fescue
Fancy red top	*Red fescue
Meadow fescue	Lacey's perennial ryegrass

*For soil having more than the usual proportion of sand increase the amounts of these.

As a strong, thick turf is desirable on flying fields, the grass seed should be sown at the rate of from 150 to 200 lb. per acre according to the fertility of the soil.

Roadways and Railroad Tracks.—Roadways should be provided to connect each of the field buildings with the entrance and with each other. The arrangement should be as comprehensive as funds will permit so that drivers will use these roadways in preference to driving over the sod. It is advisable to regard most of the roads as double track and to surface them over a width of 16 ft. Where there is little possibility of vehicles passing each other, they could be constructed as single track, 8 ft. wide. As these roads may be expected to be neglected to quite some extent, they should be well drained and crowned. If a railroad spur is to be brought into the field it should be carried along back of the hangar, shop, garage and stockroom buildings. In the case illustrated, such a spur is provided and space is left for a future parallel track with crossovers so that cars may be left behind any one of the buildings.

Field Markings—Two types of markers for the guidance of pilots should be provided in the layout. These are the field marker and the international marker. The first serves the purpose of identifying the field and showing the direction of the runways. Assuming the adoption of the Air Service recommendations, it will consist of a white circle, as shown in Fig. 4, inside of which are lines indicating the direction of the runways. The international marker was created by the International Air Convention, to which the United States is a signatory, and is designed to enable pilots to identify the towns in which the field is located. This marker is intended to be placed on the right hand side of every railroad track where it enters the town. Only in some of these cases will one of these markers be adjacent to the field, but they should be constructed

during the construction of any municipal field where they do not already exist. The Air Service recommends placing one of these markers on the northwest corner of each landing field where not adjacent to the one by the railroad track. This should be good practice to follow.

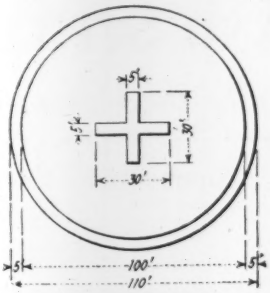


FIG. 4. FIELD MARKER

A marker of this type is shown in Fig. 5. The open-sided rectangle represents the lower or upper half of the quadrangle formed by the lines of latitude and longitude, while the dot represents the relative position of the town in this quadrangle. The numbers indicate the latitude and longitude of the south and west sides of the quadrangle. Either the name of the town or the telegraphic call of the field may be added as shown. The most convenient and practical method of constructing markers of either type is to remove the sod, fill in with broken stone, or other suitable material, and tamp or roll down. Only the large sizes of stone should be used. The thickness after rolling should be 4 to 6 in. and the stones should be whitewashed or painted to increase visibility of the marker.

Miscellaneous—If water pipes are available in the vicinity of the field, lines should be extended into it and to each shop, hangar, etc., building. If no water line is available, a well should be sunk as the water supply is of considerable importance. Where electric power and telephone lines are available anywhere in the vicinity, these should be extended into the field, the power lines being carried into each and every building, the telephone line into the field office at least. Every effort should be made to confine the line poles to the

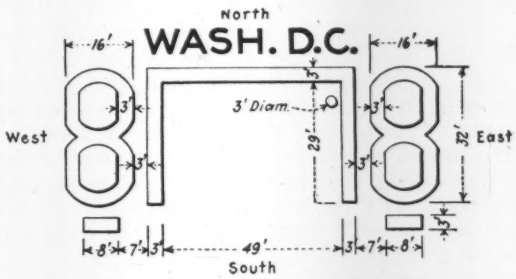


FIG. 5. INTERNATIONAL MARKER

rear of the field buildings. In any case, where they pass the ends of the runways, even if outside the field, they should be lowered. If radio equipment is to be installed, the preferable arrangement is to provide a remote controlled station with the aerials at least ten times their height distant from the field. Where this cannot be done, they should be as low as possible and located directly in back of the buildings. No matter where they are located, they should be rendered as visible as possible both by day and night. This may be obtained by painting the towers or poles in alternate stripes of black and white and by mounting small electric lights on the extreme points of each. In most cases it is advisable to fence the field along the side of the public roadway. If the surroundings are quite undeveloped it will not be necessary to carry this fence around the entire field, but it will probably be sufficient to carry it back from the public highway about a couple of hundred feet to discourage entry by other than the regular gate. All buildings, fences, etc., on the field, and any dangerous obstacles outside of it, should be so painted as to be very plainly visible.

Hydraulic Laboratories in the United States

A PAMPHLET on the hydraulic laboratories of the United States, compiled by the Engineering Foundation, New York City, from special reports gathered by it, lists 57 such laboratories and describes 49 of them. The descriptions are under 12 heads, on a uniform plan. As the pamphlet contains no summaries (beyond the statement that 49 laboratories are described) and in the hopes of securing additions to the list, if there are omissions (as the Foundation thinks likely) *Engineering News-Record* has made up the accompanying table and foot note summary:

HYDRAULIC LABORATORIES IN THE UNITED STATES
Table Made up from a Pamphlet Compiled by the Engineering Foundation.

Name of Laboratory	Year Established	Possibilities for Outside Work	No. on Regular Staff
Allis-Chalmers	1914	No	2 to 10
Armour Institute	1903 (about)	Yes	7 (part time) besides mech. and helpers
Assoc. Factory Mutual	1889	Yes	11
Brooklyn Polytechnic	1900	Yes	2 (besides mech. when needed).
Brown Univ.	1903	Yes	3 to 5
Bureau Standards	1915	Yes	Not given
Cal. Inst. Tech.	1911 (about)	Yes	About 3
Univ. California	1902	Yes	1
Carnegie Inst. Tech.	1913	Yes	2
Case School	1892	Yes	4
Cochrane (Co.)	1914	Yes	4 (on and off)
Colo. College	1915	No	1 (in charge)
Colo. Expt. Sta.	1913	Yes	3
Columbia Univ.	1899	Yes	2 assigned; others available
Cornell Univ.	1898	Yes	2
Dartmouth Col.	Activities confined to class work		
Harvard Eng. School	1890	Yes	4 (usually)
Holyoke W. Power Co.	1882	Yes	As needed
Horton Hyd. Laby.	1915	Yes	3
Univ. of Ill.	1891	Not usually	4 or 5 (12 available)
State Univ. of Iowa	1920	Yes	2 research assts. on half time, one mech. full time
Johns Hopkins Univ.	1917	Yes	2 (part time)
Lafayette Col.	1898	Yes	1
Lehigh Univ.	1911	Yes	3
Leland Stanford Univ.	1913	Yes	1 in each of 2 labs. with student assts. as needed
Lowell Locks & Can.	1792	Yes	Not stated
M.I.T.	1915	Yes	8 (about)
Univ. Mich.	1916	Yes	Not stated
Univ. Minn.	1911	Yes	3
Univ. N. C.	1921	Yes	2 (part time)
Ohio State Univ.	1885; probably earlier	Yes	4 prof. and research instructors as needed
Penn. State Col.	1895 (about)	Yes	3 instructors in lab.
Univ. Pa.	1906	Yes	3 of faculty usually, besides mech. and helper
Univ. of Pittsburgh	1918	Yes	Operated 2 weeks at end of spring term by staff of 3
Princeton Univ.	1905	No	0.05
Purdue Univ.	1911	Yes	2
R.P.I.	1908	Yes	10 (at least) competent to do work
Univ. Rochester	Not given		.....
Rose P. I.	1878	No regular	1
S. Morgan Smith Co.	1921	No	3 or 4 when needed
Stevens I.T.	1875	Very little	6
Syracuse Univ.	Not given	Not given	Not given
Univ. Texas	1904	Yes	3
U. S. Naval Acad.	1903	Yes	60 and 95 mech. & laborers
Wash. Univ.	1909	Limited	2
Wis. Univ.	1905	Yes	5
Worcester P. I.	1895	Limited	2 or 3
Yale Univ. A	1892	Yes	1
Yale Univ. B	1911	Yes	3

Summary: Of 49 laboratories in above list, 41 are connected with 40 different engineering schools, including the U. S. Naval Academy; 5 are run by companies and 1 by a consulting engineer; 1 by the U. S. Bureau of Standards and one by the Associated Factory Mutual Companies. The distribution of the 49 laboratories by years established is as follows:

Year	No.	Year	No.	Year	No.	Year	No.	Year	No.
1792	1	1890	1	1900	1	1908	1	1916	1
1875	1	1891	1	1902	1	1909	1	1917	1
1878	1	1892	2	1903	3	1911	5	1918	1
1882	1	1895	2	1904	1	1913	3	1920	1
1885	1	1898	2	1905	2	1914	2	1921	2
1889	1	1899	1	1906	1	1915	4	....	3

From the more detailed information given in the pamphlet, it appears that in many cases not so indicated the "regular staff" is not engaged on a full-time basis, but is sometimes engaged in other work.

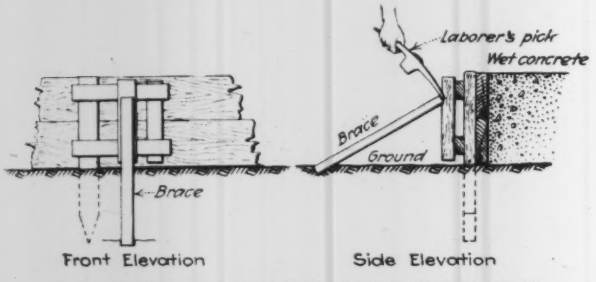
FROM JOB AND OFFICE

Hints That Cut Costs and Time *For the Contractor and the Engineer*

Bracing a Concrete Sidewalk Form

BY D. H. FLEMING
City Engineer, Owen Sound, Ontario, Can.

RATHER an ingenious "stunt" was executed here recently on a concrete curb and sidewalk job. Forms sufficiently braced began to bulge. The form setter rigged up a brace as shown in the accompanying illustration and by means of an ordinary pick jacked



PICK USED AS PINCH BAR FOR JACKING FORM

the form and its contents back into place. I have often seen the same job done in a much more clumsy fashion, using a sledge instead of the improvised pinch bar, and incidentally a great number of words not found in print.

Amount of Water in Storage Is Determined by Graph

BY GEORGE C. LOVE
Chief Engineer, Newport News Light & Water Company, Newport News, Va.

IN ORDER to determine the exact amount of water in a reservoir at any height of water surface, and the area of the submerged surface, the accompanying graph, which is greatly reduced in scale, was evolved. The large graph in use has proved very convenient, and the general method pursued in making it may interest other water-works engineers.

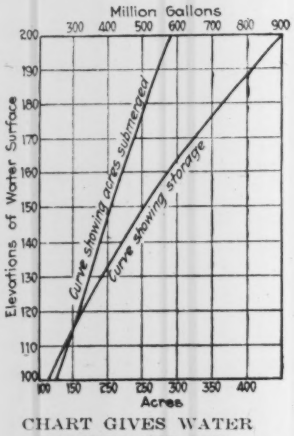

Million Gallons
300 400 500 600 700 800 900
200 190 180 170 160 150 140 130 120 110 100
Elevations of Water Surface
Curve showing acres submerged
Curve showing storage
100 150 200 250 300 350 400
Acres

CHART GIVES WATER VOLUME AND SUBMERGED AREA

The data from which the curves were plotted were secured from elaborate surveys. The contours were plotted to large scale and the areas measured by planimeter. Elevations were secured by taking soundings from known water levels, each sounding position being located by stadia from stations in a closed traverse.

Pumpage from storage was measured by a venturi meter and platted daily on the graph, together with rainfall, temperature and water-surface elevation.

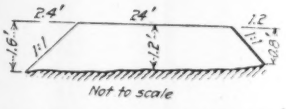
Shortcutting Earthworks Computations by Slide Rule

BY KENNETH H. GIDEON
Wyoming State Highway Department, Rock Springs, Wyo.

THE 10-IN. K and E polyphase slide rule may be graduated by an amateur in such a way that cubic yards may be obtained in earthwork computations direct for sections 50 ft. in length by one setting of the slide and runner.

Set the right hand index of scale *C* at 926 (0.926 = number cubic yards in a triangular prism with a base of 1 ft., an altitude of 1 ft. and a length of 50 ft.) on scale *D*. Set up the adjusting screws so the slide will be held firmly in this position. The only tools now needed will be a very small T-square and a needle.

Hold the T-square firmly against the upper edge of the rule and with the needle project scale *C* onto the space below scale *D* on the lower face of the rule. Include all graduations between (1) and (2) but omit the smallest graduations on the remainder of the rule. The same general scheme of numbering should be followed as on scale *C*. Ink graduations carefully and the scale is then ready to be used.



ROAD SECTION USED FOR SLIDE RULE COMPUTATION

Consider the section shown on the accompanying figure. Set the runner at 1.2 (the center fill) on the new scale. Run the slide to the left till 27.6 (the sum of the two outside distances) on the reciprocal scale *CI* coincides with the runner setting. The right hand index of scale *C* now reads 30.7 on scale *D*. This is the number of cubic yards in the prism just considered for a length of 50 ft. Now set the runner at 2.4 (the sum of the two outside heights) on the new scale and move the slide till 12 (one-half roadway width) on scale *CI* corresponds with the setting of the runner. The right hand index on scale *C* now reads 26.7 on scale *D*. The sum of 26.7 and 30.7 (57.4) is the number of cubic yards in that particular section taken for a distance of 50 ft.

Treat the adjoining section in a similar manner and the sum of the results will be the quantities between the two sections, if the distance is 100 ft. For a short station, multiply the result of the addition of the two quantities by the length of the station in terms of 100 ft.

Irregular sections are computed in the same general manner as is used in the end area method. At any point set the runner on the height given, on the new scale. The setting for scale *CI* will now be the difference between the distances out of the points on either side of the reading considered.

Follow this scheme across the section and add the results, not forgetting of course to subtract the last quantity obtained, if any intermediate reading occurs outside the roadway width.

Specially Designed Hoisting Equipment Is Part of Efficient Concrete Plant

AN AVERAGE of 468 cu.yd. of concrete was poured per 10-hr. day in the three weeks actual working time necessary to erect the first half of the terminal public market being constructed for the City of Newark, N. J., by the Clifford F. MacEvoy Co., of that city. Though 42 days were consumed in building the first portion, only three weeks actual working time were put upon it. With a simple and efficient concreting plant the above average was maintained and with an 80-ft. vertical haul a maximum of 768 cu.yd. of concrete were chuted to place in one day of 9 hr. 50 min.

The plant consists in a hoist tower 180 ft. in height, set in the approximate center of the building with chuting running in either direction; two timber tail towers about 100 ft. high supporting, together with the hoist tower, the chuting; a 1-yd. mixer and a specially designed hoist. Due to the efficient operation of this latter piece of equipment and the simplicity of the rest of the layout, the contractor has been able to maintain a high average in placing concrete. The hoist is a single 24-in. drum hoist located in the basement of the building and driven by a 75-hp. electric motor which also operates the mixer. The hoist is the friction type but with special wood blocking. Its principal features are a foot brake made of two circular bands of ¼-in. steel circling the flanges of the drum, supported at the top by hangers running from the block upon which the hoist is mounted; and an automatic stop, which precludes the possibility of a load being lost even though the motor and brake both go wrong. The brake is lined with a fibrous material of ¼-in. thickness into which has been inlaid fine strips of copper. The hoist engineer is able to control the bucket lowering entirely with the brake, never relying on the clutch. As many as 84 batches of concrete in one hour have been raised a distance of 100 ft. by this hoist. The hoist was built by the National Hoisting Engine Co., Harrison, N. J.

The terminal market is entirely of reinforced-concrete and will be of three stories with another story as a possible future installation. The upper floor is to be used for automobile storage.

What "Job and Office" Is

FOR some time the articles which make up the "Job and Office" section have been addressed in part to the "average engineer." There are those who object to this term, who say that you cannot average engineers and that the articles are aimed at "a high-grade man on his way up or a man of inferior ability who is stalled or on his way down."

There is something in this criticism. To be classed as "average" is not flattering to most men. Self-esteem calls for a higher rating. So we are going to withdraw the "average engineer" part of the sub-title.

But the subject matter of these "Job and Office" articles should not be misunderstood as they have been by the critics mentioned. "Average engineering," in its original intent, represented the body of engineering practice, the multitude of little things which, one by one, make up the great whole of a completed engineering project. They are the day's work of the engineer. To assume that such devices and solutions as are described in this section are beneath the notice of the engineer who has arrived is to misunderstand what engineering is, to ascribe too much significance to the occasional engineer who moves in higher circles intent only on the broad problems of industry, economics and natural forces and who delegates most of what the rest of the profession calls engineering to his subordinates. There are such engineers, but they are rare and engineering literature only in small part is addressed to them.

"From Job and Office" is for and from the engineer and contractor who are doing things in a new way, who have time in the pursuit of the general to concentrate on the specific, who realize that a successful engineering performance requires about twenty per cent visualization of the whole and about eighty per cent satisfactory execution of the details.

Floor Forms Protected in Stripping by Ropes Stretched Beneath Them

By E. F. Clasby
Field Superintendent, Aberthaw Construction Co., Boston

IN A multi-story reinforced-concrete building where floor forms are used several times, each successive use leaves the ceiling surface a little rougher due to the poorer condition of the forms through having been damaged in stripping and handling.

In a building under construction for the Dennison Manufacturing Co. at Marlboro, Mass., special requirements of the owner made it necessary to pay particular attention to ceilings. Accordingly, the writer devised a scheme of rope supports for breaking the fall of the floor forms when they were stripped. These ropes were stretched crosswise of the building between columns and fastened as high up on the columns as the mushroom head would allow. Other ropes were run between these in pairs and spaced far enough apart so that they would catch the ends of the floor panels when the panels were removed. The result was that most of the panels were caught on the ropes, but in the case of those that did not, their fall was so broken that they were little damaged. When re-used these forms gave practically as good a surface as after the first use.

This method has resulted in ceiling surfaces in the upper stories being much better than is usually the case. In fact, the difference in smoothness between the underside of the roof slab and the first story slab is not noticeable. The labor cost of placing the ropes was practically offset by the saving in repairing forms.

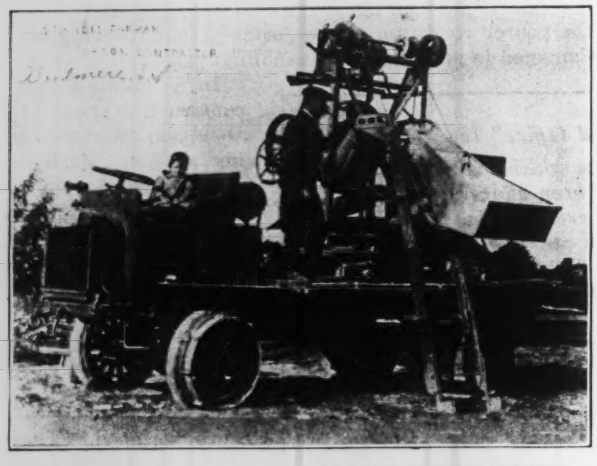
On Estimating Floor Slabs

In *Engineering News-Record* of Aug. 24, p. 305, information was asked for on the practice of estimating that portion of the floor slab which rests in the wall. The following is one of the replies, being from Charles F. Dingman of Palmer, Mass.:

"I have never heard that any standard practice had been adopted by other contractors, but it has always been my practice to consider it as a part of the slab."

Mixer Moved on Motor Truck Fitted With Steel-Flanged Wheels

DIFFICULTY in moving his concrete mixer led Stanley Carman, a masonry contractor of Woodmere, Long Island, N. Y., to fit up a motor truck so that the mixer could be taken anywhere with the greatest



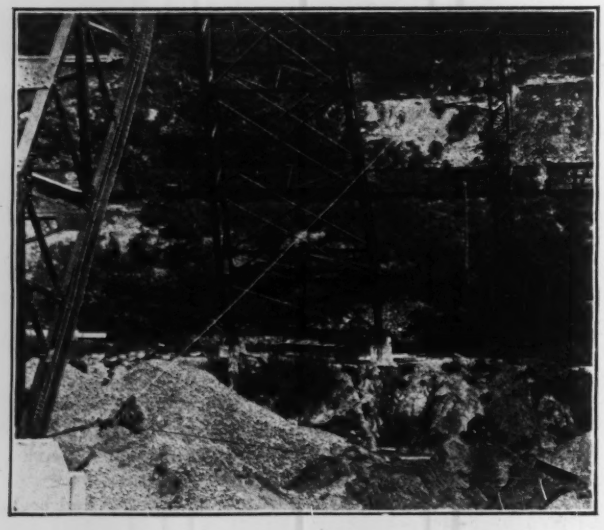
STEEL FLANGES ALLOW EASE IN MOVING MIXER

ease. He mounted the mixer on the truck and then put 10-in. steel flanges on the front wheels and 12-in. steel flanges on the rear wheels. Thus the time of moving the mixer from one job to the next was reduced to the minimum and the flanged wheels facilitated the placing of equipment in just the location where it could be used to the best advantage.

The information from which this article was written was furnished by the Four-Wheel Drive Auto Co., Clintonville, Wis.

Drag Scraper and Crane Clean up Stockpile

STORAGE of crushed stone by the Canada Crushed Stone Co., Ltd., Dundas, Ont., Can., is effected by distribution with a belt conveyor mounted on a high



DRAG SCRAPER OPERATED BY CRANE TO PULL MATERIAL OVER MATERIAL TUNNEL

FROM JOB AND OFFICE

Hints That Cut Costs and Time

trestle. To return the material to the crushers and loading bin a belt conveyor operates in a concrete tunnel below the stockpile. When the material in the center, which falls by gravity through gates in the top of the tunnel onto the belt, has been drawn out, a pile on each side is left to be moved over the tunnel. To do this work a crane operating a power drag scraper on an adjacent side track is utilized. As the material is located on both sides of the tunnel half of it must be pulled toward the crane and the remainder dragged away from the crane. The set-up as shown in the photograph is arranged for reverse scraper operation.

The storage pile varies from 100 to 150 ft. in width at the base so that it is too long a reach for the boom to handle the material in one pick-up with a clamshell even were there room between the columns of the trestle legs. As most of the material has to be moved only a short distance the scraper can be operated faster than a clamshell.

Tables and Formulas for Wind Stresses in Office Buildings

By Camillo Weiss
Structural Engineer, Bethlehem, Pa.

FORMULAS and tables are presented herewith for the determination of wind stresses in the steel frames of tall buildings. They are based on the cantilever method (R. Fleming's Method I, *Eng. News*, Mar. 13, 1913). Column sections are assumed to be equal, and the unit wind pressure is taken as constant from the story under consideration up.

The underlying assumptions, briefly repeated, are: (1) All columns in any given story have equal sections, and the direct stresses are proportional to the distances from the neutral axis of the bent; (2) the point of contraflexure of each column is at mid-height of the story, and the point of contraflexure of each girder is at its mid-length; (3) the joints are perfectly rigid. In addition, the unit wind pressure has been taken as constant from the story under consideration up. If the unit wind pressure is a variable, the values obtained are to be modified as stated below.

These assumptions, although more or less arbitrary, are not so artificial as to vitiate the very satisfactory application of the method to most practical cases. Comparison with exact methods revealed it to be more nearly correct than either Method II or III of Mr. Fleming's article (See W. M. Wilson and G. A. Maney, Bull. No. 80, Eng. Exp. Sta., Univ. of Ill.).

In the case of an irregular bent the formulas will furnish results more rapidly than can generally be obtained by the analysis of successive joints.

For the case of a symmetrical bent with equal spans the tables give coefficients of direct stresses and bending moments in columns, and bending moments at the ends of girders, for bents of one to ten spans.

Variations in the heights of consecutive stories have no influence on direct stresses and no material influence on bending stresses. Where such variations occur, and accurate bending moments are desired, they are obtained by multiplying tabular values by the correction factors given with the formulas.

FROM JOB AND OFFICE

For Contractor and Engineer

S. W. Bradshaw, Assistant Engineer of the Bethlehem Steel Bridge Corp., checked the formulas and tables.

In the formulas given below, the following notation is used:

L_A, L_B, L_C, *etc.* = spans, feet;

H = distance from the top of the story under consideration to the top of the building, feet;

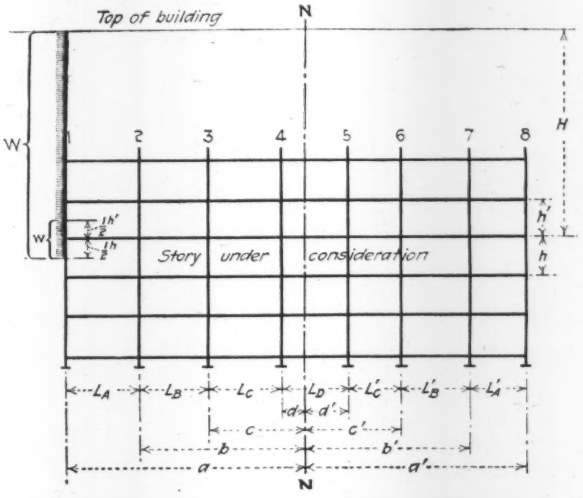
h = height of the story under consideration, feet;

h' = height of story above, feet;

W = total wind load above midheight of the story under consideration, pounds;

w = wind load in a story height, pounds;

D_1, D_2, D_3, etc. = direct stresses in columns 1, 2, 3, etc., in story under consideration, pounds;



OFFICE-BUILDING DIAGRAM FOR WIND-PRESSURE CALCULATION

M_1, M_2, M_3, etc. = bending moments at ends of columns 1, 2, 3, etc., in story under consideration, foot-pounds;

M_A, M_B, M_C, etc. = bending moments at ends of corresponding girders in story under consideration, foot-pounds;

N-N = neutral axis, so located that

$a + b + c + d + \ldots = a' + b' + c' + d' + \ldots$

in which a, b, c, $\ldots$ a', b', c', $\ldots$ are the distances from the neutral axis to the corresponding columns, feet;

$$Q = (a)^2 + (a')^2 + (b)^2 + (b')^2 + (c)^2 + (c')^2 + \ldots \text{ etc.}$$

Direct Stresses in Columns—Direct stresses are,

$$D_1 = \frac{W}{4Q} \times (2H + h)a$$

$$D_2 = \frac{W}{4Q} \times (2H + h)b$$

$$D_3 = \frac{W}{4Q} \times (2H + h)c$$

TABLE I—DIRECT STRESSES IN COLUMNS DUE TO WIND

Bent symmetrical about center line; all spans L equal

No. of Spans in Bent	Coefficients of $\frac{b}{L}(2H + h)$ Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col.
1	$+\frac{1}{4}$	$-\frac{1}{4}$				
2	$+\frac{1}{8}$	0	$-\frac{1}{8}$			
3	$+\frac{3}{40}$	$+\frac{1}{40}$	$-\frac{1}{40}$	$-\frac{3}{40}$		
4	$+\frac{2}{40}$	$+\frac{1}{40}$	0	$-\frac{1}{40}$	$-\frac{2}{40}$	
5	$+\frac{5}{140}$	$+\frac{3}{140}$	$+\frac{1}{140}$	$-\frac{1}{140}$	$-\frac{3}{140}$	$-\frac{5}{140}$
6	$+\frac{3}{112}$	$+\frac{2}{112}$	$+\frac{1}{112}$	0	$-\frac{1}{112}$	$-\frac{2}{112}$
7	$+\frac{7}{336}$	$+\frac{5}{336}$	$+\frac{3}{336}$	$+\frac{1}{336}$	$-\frac{1}{336}$	$-\frac{3}{336}$
8	$+\frac{4}{240}$	$+\frac{3}{240}$	$+\frac{2}{240}$	$+\frac{1}{240}$	0	$-\frac{1}{240}$
9	$+\frac{9}{660}$	$+\frac{7}{660}$	$+\frac{5}{660}$	$+\frac{3}{660}$	$+\frac{1}{660}$	$-\frac{1}{660}$
10	$+\frac{5}{440}$	$+\frac{4}{440}$	$+\frac{3}{440}$	$+\frac{2}{440}$	$+\frac{1}{440}$	0

The direct stresses are tension (+) in the colum on the windward side and compression (—) in columns on the leeward side of the neutral axis of t building bent.

Bending Moments—The bending moments at ends columns are

$$M_1 = \frac{Wh}{Q} \times \frac{aL_A}{4}$$

$$M_2 = \frac{Wh}{Q} \times \frac{aL_A + (a + b)}{4}$$

$$M_3 = \frac{Wh}{Q} \times \frac{(a + b)L_B + (a + b + c)L_C}{4}$$

Etc.

TABLE II—MOMENTS IN COLUMNS AND GIRDERS DUE TO WIND

Bent symmetrical about center line; all spans equal and two consecutive story heights equal.

No. of Spans in Bent	Moments at Ends of Columns, Coefficients of Wh Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Moments at Ends of Girders, Coefficients of wll Span 1	Span 2	Span 3	Span 4	Span 5
1	$\frac{1}{4}$	$\frac{1}{4}$					$\frac{1}{2}$				
2	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$				$\frac{1}{4}$	$\frac{1}{4}$			
3	$\frac{3}{40}$	$\frac{7}{40}$	$\frac{7}{40}$	$\frac{3}{40}$			$\frac{3}{20}$	$\frac{4}{20}$	$\frac{3}{20}$		
4	$\frac{2}{40}$	$\frac{5}{40}$	$\frac{6}{40}$	$\frac{5}{40}$	$\frac{2}{40}$		$\frac{2}{20}$	$\frac{3}{20}$	$\frac{3}{20}$	$\frac{2}{20}$	
5	$\frac{5}{140}$	$\frac{13}{140}$	$\frac{17}{140}$	$\frac{17}{140}$	$\frac{13}{140}$	$\frac{5}{140}$	$\frac{5}{70}$	$\frac{8}{70}$	$\frac{9}{70}$	$\frac{8}{70}$	$\frac{5}{70}$
6	$\frac{3}{112}$	$\frac{8}{112}$	$\frac{11}{112}$	$\frac{12}{112}$	$\frac{11}{112}$	$\frac{8}{112}$	$\frac{3}{56}$	$\frac{5}{56}$	$\frac{6}{56}$	$\frac{6}{56}$	$\frac{5}{56}$
7	$\frac{7}{336}$	$\frac{19}{336}$	$\frac{27}{336}$	$\frac{31}{336}$	$\frac{31}{336}$	$\frac{27}{336}$	$\frac{7}{168}$	$\frac{12}{168}$	$\frac{15}{168}$	$\frac{16}{168}$	$\frac{15}{168}$
8	$\frac{4}{240}$	$\frac{11}{240}$	$\frac{16}{240}$	$\frac{19}{240}$	$\frac{20}{240}$	$\frac{19}{240}$	$\frac{4}{120}$	$\frac{7}{120}$	$\frac{9}{120}$	$\frac{10}{120}$	$\frac{10}{120}$
9	$\frac{9}{660}$	$\frac{25}{660}$	$\frac{37}{660}$	$\frac{45}{660}$	$\frac{49}{660}$	$\frac{49}{660}$	$\frac{9}{330}$	$\frac{16}{330}$	$\frac{21}{330}$	$\frac{24}{330}$	$\frac{25}{330}$
10	$\frac{5}{440}$	$\frac{14}{440}$	$\frac{21}{440}$	$\frac{26}{440}$	$\frac{29}{440}$	$\frac{30}{440}$	$\frac{5}{220}$	$\frac{9}{220}$	$\frac{12}{220}$	$\frac{14}{220}$	$\frac{15}{220}$

If consecutive story heights vary considerably, these moments should be multiplied by the factor

$$\frac{4H + (h - h')}{4H + 2(h - h')}$$

The bending moments at ends of girders are,

$$M_A = \frac{wH}{Q} \times \frac{aL_A}{2}$$

$$M_B = \frac{wH}{Q} \times \frac{(a + b)\,L_B}{2}$$

$$M_C = \frac{wH}{Q} \times \frac{(a + b + c)\,L_C}{2},$$

Etc.

(Note that for constant unit wind pressure throughout height H we have $wH = Wh - \frac{wh}{2}$).

If consecutive story heights vary considerably, the girder moments from the formulas should be multiplied by the factor $\frac{4H + (h - h')}{4H}$.

Unit Wind Pressure a Variable—Some building codes prescribe variable unit wind pressure, as the building laws of Boston and Philadelphia, for instance. If the unit wind pressure varies throughout height H, the direct stresses in the columns are obtained from the overturning moment, M, by the formulas $D_1 = Ma/Q$, $D_2 = Mb/Q$, etc.; or, for symmetrical bents with equal spans these stresses may be found by multiplying $\frac{4M}{L}$ by the coefficients given in Table I.

The bending moments at ends of columns are obtained directly from the formulas and tables for constant unit wind pressure. However, when variations in consecutive story heights are taken into consideration, the correction factor is

$$\frac{h + h^1}{2} \frac{2W - w}{Wh + (W - w)h^1} \text{ in place of } \frac{4H + (h - h^1)}{4H + 2(h - h^1)}$$

The bending moments at ends of girders are also obtained from the formulas and tables for constant unit wind pressure, except that the quantity $\left(Wh - \frac{wh}{2}\right)$ must be used in place of wH in all cases, as these two quantities are not interchangeable for varying unit pressure. The correction factor for variation in consecutive story heights also changes from $\frac{4H + (h - h^1)}{4H}$ to $\frac{h + h^1}{2h}$.

Arrangement of computations in tables will be found the most convenient form for making, revising and reviewing calculations.

FROM JOB AND OFFICE

Hints That Cut Costs and Time

Concrete Paving Marker and Sander

EQUIPMENT to mark concrete paving with workmanlike even width center lines on tangents and curves has been developed in the Wisconsin Highway Commission by F. M. Balsley, engineer-inspector. In addition to the marker is an apparatus to apply sand to blot the tar so that it will not be streaked over the pavement by traffic.

The marker consists of a wheelbarrow frame mounted on a wooden wheel, 5¼ in. wide and 2 ft. in diameter. A sheet-metal rim fastened to the face of the wheel carries a felt pad, ¼ in. thick and 4 in. wide. The marking fluid, cold Tarvia B, is carried in a 7-gal. can, mounted above the wheel and dripped onto the felt strip from a gas pipe. The flow is regulated by a stop cock to which is attached a lever extending back to a point on the handles within easy reach of the operator. The cast-iron lead wheel is faced with leather. Its function is to keep the marking wheel from slipping sidewise. Under the legs of the barrow frame are two small cast-iron wheels which carry the remaining weight of the machine. Between the lead wheel and marker is a steel wire brush to clean the pavement and prevent foreign material from collecting on the felt pad. In operation the pavement is marked down the center with a chalk line to guide the operator.

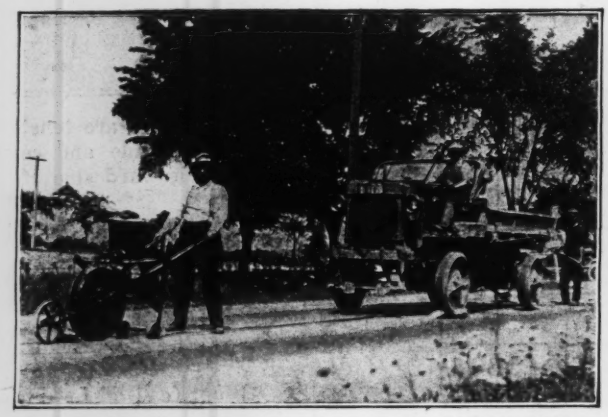


FIG. 1—CENTER STRIP CONCRETE PAVEMENT MARKER

FIG. 2—TAR SANDER

The sander is a two-wheeled apparatus equipped with 30x3½-in. pneumatic tires. One wheel is keyed to the axle on which is mounted a sprocket wheel and throw-out clutch. In the hopper above is a disk on the perimeter of which is attached eight sheet-metal cups. The disk is mounted on a ⅝-in. shaft operated through chain drive from the axle. In rotating the disk picks up sand and throws it through an opening leading by a downspout directly over the tarred strip. The sander is attached to the rear end of a truck which follows the marker. It is fed by one man with a shovel.

Six laborers and a truck driver are required to handle the marker and sanding equipment efficiently. About 5 miles of pavement is a fair day's work. Ten gallons of tar will mark a mile of pavement and ½ yd. of dry sand will blot the tar.

FROM JOB AND OFFICE

For Contractor and Engineer

Estimating the Cost of Buildings by Superficial Areas

By W. F. Silliman

Asst. Engineer, Dept. of Valuation, Phila. & Reading Ry., Philadelphia, Pa.

THE extensive work involved in the government valuation of railroad properties has necessitated extensive study in devising short-cut methods of determining true values with the minimum of labor.

The general method adopted for estimating the cost of buildings is that of pricing by the cubic feet of volume, placing the buildings in various types dependent on similarity of construction and design. Although this method will give a fairly true total value in dollars for all the buildings assigned to any one type, it does not, owing to the various shapes and heights of the buildings, always reflect the true value of the individual building in the type.

For illustration, take two brick buildings of similar construction, one 40 ft. square x 15 ft. high and the other 20 ft. wide, 80 ft. long and 15 ft. high. The cubic-foot volume of these two buildings is the same, and the same cubic-foot price would be applied to determine the cost of each. However, the wall area of the second would be 600 sq.ft. greater than that of the first, and if the walls were 12 in. thick, this area, computed into material would represent approximately 12,500 brick. Excess quantities would be the rule on all material used on vertical surfaces and running around the perimeter of the building. The actual cost of the second building, therefore, would be greater than that of the first. It is true that the first building would require additional intermediate supports, but the cost of this is negligible compared with the additional material in the second building.

With slightly more labor this inconsistency in estimating the cost of buildings may be overcome by the superficial area method; that is to say, by estimating on the basis of the areas which by their nature require different construction. In a simple one-story brick building the areas above the foundation would consist of the wall, roof, floor, ceiling and partitions.

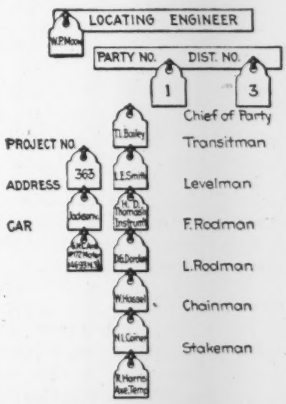
A bill of material would be taken off for the building and the quantities obtained allocated to the areas in which they occur. Generally speaking, the wall area would consist of the brick, windows and doors, plaster, trim, hardware and paint. The roof area would consist of the roof covering, boarding, rafters, collar-beams, cornices, gutters and downspouts. The floor area would consist of the floor joists, bridging, sub-floor and finished floor. The partition area would consist of the studding, doors, trim, plaster, hardware and paint. The ceiling area would consist of the ceiling joists and plaster. By applying the cost of material and labor to the quantities included in the various areas, and dividing the products by the corresponding superficial areas, the quotients will be the unit prices to apply to the corresponding areas of any similar building.

This method may be used in the same manner as the cubic-foot method, by creating types, or would be adaptable to all ordinary buildings by working up a sufficient number of superficial area unit prices.

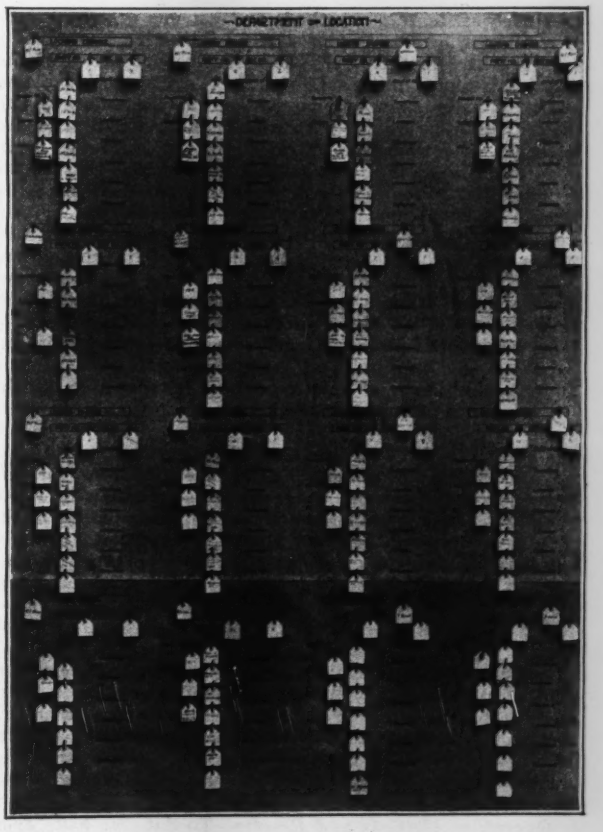
Chart Records Movements and Personnel Changes of Many Survey Parties

WITH half a score of locating parties being shifted from district to district and from project to project and being enlarged or reduced by transferring employees, the task of recording their positions and personnel is simplified by the flexible chart illustrated here as used by the department of location of the North Carolina State Highway Commission.

This chart has a capacity of sixteen parties. There are listed for each party one locating engineer, a chief of party, a transitman, a levelman, two rodmen, a chainman and a stakeman. This list is lettered on the chart which is spread on a "board" and a small hook is inserted opposite each title. There are also hooks for the district number, the party number, the project number, the address of party headquarters, and the designating number of the party motor car. On the hooks are hung cardboard tags on which are lettered the required numerals or the names of the men or other designating data. When changes occur, the tags are shifted or new tags are made out and hung in their proper places.



DETAIL OF CHART



ROAD SURVEY-PARTY CHART

A New Method of Purifying Water

By H. W. Clark
Chief Chemist, Massachusetts Department of Health, Boston

Abstract of paper presented at the New England Water Works Convention, New Bedford, Mass., Sept. 12-15, 1922.

PROBABLY the chief objection to slow sand filtration is that it seldom removes from the comparatively clear but often highly colored waters of the eastern states more than from 25 to 30 per cent of color, and hence does not produce a filtrate as clear, sparkling, low colored and altogether attractive as that from coagulation and rapid filtration. On the other hand, perhaps the chief objections to coagulation and rapid filtration when applied to these soft, highly colored waters, are the tendency of this treatment to increase the corrosive properties of the soft water treated, the difficulty of obtaining as good bacterial results, generally speaking, as by slow sand filtration, and the fact now again being widely commented upon that occasionally aluminum sulphate does pass through rapid filters. A process of water treatment that will produce a sparkling water of low color without increasing its corrosive properties has been much desired. Such a method I believe we have worked out at the Lawrence Experiment Station of the Massachusetts Department of Public Health.

Filter Loaded with Coagulant—The process consists of loading the sand of a slow sand filter with the ordinary coagulants used in mechanical filtration and operating the filter at slightly more than the usual sand filter rates, or about 5 or 6 m.g.d. per acre. Filters loaded in this way remove a very large percentage of the organic matter especially the coloring matter of the applied water and produce a clear, sparkling and altogether attractive effluent, containing no more carbonic acid than was in the raw water although the carbonate constituents are slightly increased.

This method of water treatment has many advantages over each of the other methods and but one drawback [the drawback is low bacterial removal—Editor]. The advantages are as follows: (1) The corrosive properties of the effluent are not increased, or if so, not materially, and neither is aluminum sulphate found in the effluent; (2) the aluminum hydroxide with which the filter is first loaded is regenerated whenever its color-removal properties begin to fail and hence is used over and over again—that is, the primary cost of coagulants is practically the final cost; (3) when receiving comparatively highly colored water from storage reservoirs practically free from mineral matter in suspension, such as silt, etc., the method of filter regeneration or removal of stored color which we employ, removes practically all organic matter from the surface of the filter, as well as from its deeper portions, and hence the necessity for scraping the filter is largely obviated—that is, the expense of sand removal and sand washing is reduced to a minimum. Filters of this type now in operation at the Experiment Station have been scraped only once or twice during a period of five years' operation at rates of 5 m.g.d. per acre; (4) there is, as I have already stated, practically no consumption of alum. Filters operated now for five years have theoretically used, up to date, taking into consideration the amount of aluminum sulphate placed in the filter and the volume of water filtered, about 0.2 of a grain of sulphate per gallon of water filtered or practically one-twelfth the rate necessary for successful mechanical filtration of the Merrimack River water applied to these loaded filters. As the loaded filter increases in age and the volume of water filtered and decolorized increases, the theoretical or apparent use of alum grows less and less per gallon. Successful mechanical filtration of Merrimack River water costs $6 to $7 p.m.g. for aluminum sulphate while with this new method the cost to date has been about $0.55 p.m.g. If the new process is continued on the present basis for another five years the cost for sulphate will be only $0.28c. per million gallons.

Operating Methods and Results—To date we have operated eleven filters loaded with aluminum sulphate. One filter, put into operation in January, 1917, with 4½ ft. of sand having an effective size of 0.25 mm., was loaded with 8 tons of aluminum sulphate per acre of filter surface. The aluminum hydroxide was precipitated in the sand by flooding the filter alternately with small doses of solutions of soda ash and sulphate, although the filter can be loaded by mixing an alkali, such as magnesium carbonate, with the dry sand and then applying solutions of the sulphate. During its five years of operation the average color of the effluent from this filter has been 14 and the color of the water applied to it, 41—a removal of 66 per cent. During long periods the color of the effluent has averaged 7, and during portions of these periods the applied water has had a color of 60, 70 and even 75; that is, the filter has given an average color removal during such periods of 90 per cent. In other words, the color line of the effluent has always been nearly straight while the color of the applied water has had many high peaks and the higher the color of the applied water the greater the percentage of the coloring matter removed. To date this filter has removed rather more than 50 per cent of the organic matter determined as albuminoid ammonia and 60 per cent of that determined as oxygen consumed. It has been treated with weak solutions of caustic soda 24 times in five years in order to remove the coloring matter held in the filter by the aluminum hydroxide. After this treatment with caustic such a filter is washed with a volume of water equal to about 2.5 per cent of that filtered between treatments and is then ready for service for a period of two or more months. It is not necessary to use filtered water to wash out the caustic. The amount of caustic used up to date in the filter described has been 0.5 of a grain per gallon of water filtered, and the expense for the caustic used has been about $2.50 p.m.g. We believe, however, judging from later results, that we have used in this particular filter an excessive amount of caustic.

The bacterial results from this method are poor as the caustic used removes from the sand grains the gelatinous organic matter so necessary for the retention of bacteria but the effluent—clear, colorless and sparkling—is easily rendered practically sterile by the use of small amounts of chlorine, and chlorine is in almost universal use at filter plants at the present time in order that their effluents may be absolutely safe.

This method of treatment is particularly applicable to stored waters of a high color, the improvement of which physically is of more moment than the reduction of bacteria and it has seemed to us that there is no serious objection to it which would prevent its use upon a large scale.

Discussion: In answer to questions, Mr. Clark stated that he had not tried the new method at rates in excess of 6 m.g.d., and that its efficiency would depend upon the amounts of turbidity and vegetable matter in the water. Frank W. Green, superintendent of filtration at the Little Falls plant of the Montclair and allied water companies, said he expected to try the process with his mechanical filters. S. De M. Gage, chemist and sanitary engineer, Rhode Island State Board of Health, remarked that, with exception of the Providence supply, bacterial removal was not a serious matter in Rhode Island, but rather the physical improvement of the water supplies. The discussion brought out the fact that experiments with the new process are to be held at Providence.

Durability of Blight Infected Chestnut

Blight infected chestnut is as durable as sound chestnut according to service records collected by the U. S. Forest Service on chestnut posts, poles and ties. Inspections on posts in one locality during eight years of service showed that decay progresses about as rapidly in undiseased posts as in blight infected posts. The blight fungus attacks living trees and grows in the bark, particularly in the cambium layer, but it does not penetrate deeply into the wood itself. The blight finally kills the tree, effectively girdling it by separating the bark from the wood. Blight-killed chestnut should be cut and utilized as soon as possible.

Reverse Studies Detect Errors in Railroad Location

Two Cases in Which Location Surveys in Opposite Directions Revealed Better Lines—Value of Running Variants

By C. K. Conard
Northport, N. Y.

THE necessity for studies of railroad locations from opposite directions, as set forth by A. M. Wellington, has been so forcibly impressed on the writer, that in going over country on location work he finds himself subject to an irresistible desire to keep looking back for possible variants that might improve the line. Even after a location has been made, it is advisable to make studies between the several controlling points, to make sure that the line selected is the most economical.

The following actual incidents illustrate the advantages to be obtained by studying stretches of line from both directions. Some years ago the writer was in charge of surveys for a low-grade freight line that the Erie R.R. contemplated building in Orange Co., New York. The work had proceeded to the point at which projections were being made from the field maps. Just north of Middletown a crossing of the N. Y. O. & W. R.R. held up the grade line in the middle of the 12-mile descent from the Otisville tunnel to the Wallkill River.

The crossing was located at a sag on the O. & W. R.R., where marshy land prevented any lowering of their roadbed. The resulting fill for the Erie line amounted to some three hundred thousand cubic yards. Furthermore, the alignment just west of the crossing was bad. In studying this situation our information was that there was no other feasible crossing of the O. & W. R.R in the vicinity and the profile seemed to bear this out. It looked like a case of accepting a bad situation.

Before doing this, however, a last effort was made. Together with an assistant, each of us carrying a compass, hand level, and aneroid barometer, the writer started out to find some point where the O. & W. R.R. could be crossed underneath, instead of overhead. Just north of Middletown yard limit the O. & W. R.R. starts down grade towards the meadows and the projected crossing. Taking the first culvert as a starting point, although the fill was only about six feet, we easily determined that our location could pass underneath, from the down-grade side. Then, striking across country to the west, and plotting a profile from estimated distances and aneroid elevations, we traversed a line that on being developed proved to be about $200,000 cheaper and a whole mile shorter than the first.

The failure to cover this line previously had come about through following a hillside in working downgrade instead of cutting across a ridge. Viewed from the up-grade side of the ridge it certainly seemed the natural thing to do, and only by working in the opposite direction was the mistake discovered. In this particular case the remedy was so simple that it was embarrassing. It was difficult to explain why the mistake had not been discovered earlier. And when you begin to explain, you are damned.

A more recent case occurred in Central America. A railroad 120 miles long, had been located, and partly constructed, some ten or twelve years ago. The original location was made running from west to east. In relocating the line a party was started at the eastern terminus, and followed the old grading. At Kilometer 8 a ridge was crossed, a 3 per cent grade being used to overcome the 140 m. of rise. As we were using 2 per cent for our maximum grade, some development was necessary. It proved impossible to use the old summit cut, although the grading was 75 per cent completed.

Although the distances involved were comparatively short, the heavy undergrowth of the tropics made it impossible to get a general idea of the lay of country without actually running lines. In this instance stadia was used for distance and vertical angles for elevations. Leaving the spur that carried the old line well out into the swamp land, we struck out on a fairly straight line along the foot of the ridge. Every stream that crossed the line was investigated to its saddle or high enough to prove that it was impracticable.

Eventually, at the end of the second day, a summit was found that promised well, and a transit line and levels were run. The notes, as platted, showed that we were close to the old grading on the west side of the ridge, with a fairly easy side-hill descent from the summit. The projected location on this variant was more than a kilometer shorter; the summit more than 10 m. lower; the maximum grade was 2 per cent instead of 3 per cent, the curvature was reduced one-half, and the grading quantities were less than on the old line. Altogether the old line was a good example of "letting it go at that." Had the construction work been completed, and the line opened for traffic, this mistake would have been discovered as soon as the forest was cleared away. The really surprising part of this discovery was that the new summit cut was towards rising ground from the old summit, and the investigation in that direction was undertaken without the slightest hope of finding anything worth while. We simply expected to make sure that it was impracticable.

As for following out this principle on projection work, there are many conflicting ideas. The writer prefers to project lines from the summits downgrade, on the idea that any necessary development for distance can better be made on low-lands, where valleys tend to be broader, and where there is usually more latitude in placing the line. At summits the line is fairly well fixed. But even so, no line should be accepted without some study of the possibilities of working upgrade.

Nothing is so indicative of inexperience as a set of expensive field maps, on which a single line shows the projected-location study. While it is true that because of map errors the first location run out on the ground in hilly country is seldom the line constructed, the final line should be a refinement of the projected location, and not a new line. Experience only, will give the judgment necessary to say just how far to go in refining a projected line, but it is well to go on the principle of never being entirely satisfied with the line laid down.

The lamentable failure not only in this country, but all over the world, to continue the laying out of new railroads, during the past eight or ten years, has caused a gradual elimination of men expert in location work. Should a period of prosperity, with a changed public opinion, permit a continuation of the railroad program, it is probable that the young men employed on that work would be lacking in practical experience. Without such safeguards as those outlined above, we should have many failures in properly laying out the work.

Precast Concrete Slab Road After Fourteen Months' Use

Abstract of Report of Inspection of Casper-Salt Creek (Wyo.) Road by B. B. Hauser, Highway Engineer, U. S. Bureau of Public Roads.

AFTER 14 months' service ending Mar. 11, the 2,400-ft. section of experimental precast concrete road on the heavily traveled route between Casper and Salt Creek, Wyo., was found in general in good condition. No visible lateral movement was observed and very little vertical displacement. In the three joints which showed the greatest amount of movement the vertical displacement was 0.05, 0.04, and 0.03 ft. The displacement of practically all other joints was negligible. All slabs are free from cracks except eight. Three slabs each show one crack across the corner extending into the slab less than 3 ft.; two slabs each show one crack across the corner extending into the slab less than 6 ft.; two slabs each show one crack extending entirely across the slab, and one slab shows one crack extending the entire length of the slab with one crack extending half of the width. All of the cracks are too fine to show in a photograph and apparently are not becoming larger, which would indicate the value of the steel reinforcement. Some of the cracks have been filled with asphalt. Eight consecutive slabs show some wear. It is understood that a number of the slabs were cast during freezing weather and wearing is undoubtedly due to frost, which is not considered a bad showing.

CURVED JOINT WITH NEAR CORNER OF ONE SLAB SETTLED 0.04 FOOT

Very little difference was observed in the service rendered by the different types of joints.

Present indications are that the precast slab pavement will continue to give good service for a considerable time with very little maintenance other than to keep the shoulders in place.

During the year 1921 trucks of 30 to 40 oil companies, the principal users of the road, made 13,000 round trips over the pavement carrying a net weight of 40,000 tons and gross weight of 97,000 tons. Considering 313 days per year the average number of trucks per day was eighty-three. All of the trucks were loaded one way only from Casper to or toward Salt Creek. About 60 touring cars daily pass over the road. It is estimated that 30 to 40 per cent of the trucks are equipped with pneumatic tires. About 50 per cent of the haulage is done by the Mid West Oil Company which has fourteen 3-ton, five 2½-ton, and one 5-ton trucks and several trailers. The average rate of speed is 12 miles per hour for the 3-ton trucks, 14 to 15 miles for the 2½-ton trucks. The heaviest single load was a crankshaft and engine base having a net weight of 22½ tons. The load was hauled on two reconstructed trailers and was equally distributed on eight 42-in. steel wheels 10 in. wide.

[*The results of the inspection of the monolithic concrete section of the same road are given in the following article.* —EDITOR.]

Inspection of Casper-Salt Creek Monolithic Concrete Road

FEDERAL inspection in March of the 4-year-old Casper-Salt Creek (Wyo.) monolithic concrete road carrying heavily laden trucks to the oil fields indicated that 92.6 per cent of the slabs are in good condition, and with a small amount of maintenance should continue to give satisfactory service for an indefinite period. The remainder need considerable maintenance. Four slabs needed replacement and in seven small portions were disintegrated. Two slabs showed wear due to poor concrete or improper curing, and one slab, which showed several hair cracks, did not show perceptible wear or disintegration.

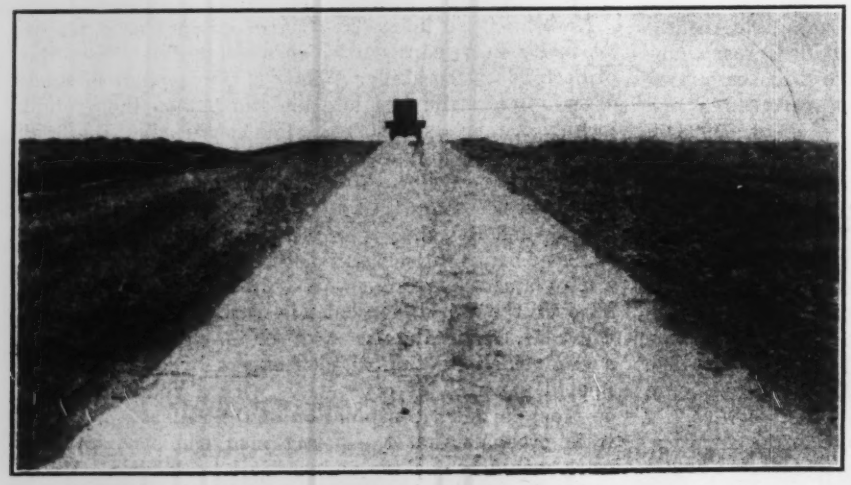
TABULATION OF CLASSIFICATION

Class	Number of Blocks	Per cent of Whole	
A	288	33.4	
B′	64	7.4	
C′	110	12.7	92.6
B	82	9.5	
C	256	29.6	
D	44	5.1	
E	6	0.7	7.4
F	4	0.5	
Special	10	1.1	
Total	864	100.0	100.0

B′ pavement has only a few plainly visible transverse cracks which extend less than one-half the distance across the pavement.

C′ pavement has only a few plainly visible longitudinal cracks which extend along the pavement less than one-half the length of the slab.

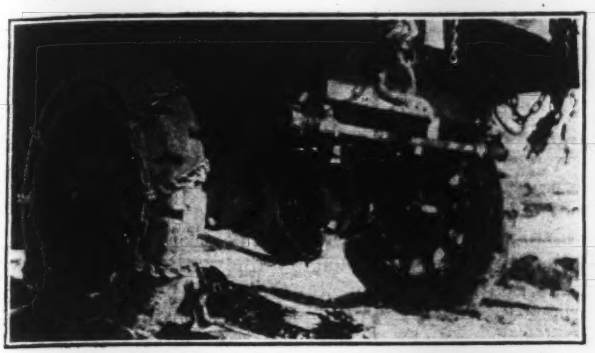
Special classification shows in more detail conditions of slabs which could not be placed under any of the above classes, such as small disintegrated portions.



CASPER-SALT CREEK PRECAST CONCRETE PAVEMENT
Eight slabs slightly worn probably due to being cast in freezing weather.

"Taken as a whole," states B. B. Hauser, engineer, Bureau of Public Roads, who made the inspection, "considering the heavy truck traffic, the quality of concrete appears to be good and the pavement is wearing well. The cracks are undoubtedly due to uneven settlement of the subgrade."

The classification of the 864 blocks given above is according to the method used by the



TYPE OF CHAINS USED ON TRUCKS ON CASPER-SALT CREEK ROAD

bureau in the study of the California highway system with two additional subsidiary classes and a special description applied to a few slabs (See *Engineering News-Record*, March 17, 1921, p. 469).

Zoning Ordinance Adopted at Akron, Ohio

UNUSUAL features of the zoning ordinance unanimously adopted by the City Council of Akron, Ohio, in accordance with recommendations of the City Planning Commission, are the restriction of building lines of all residence districts and showng them on a separate set of maps as part of the zoning ordinance; the method for taking care of uses classed as "indeterminate" and "institutional;" and provisions for garages under restrictions as to repair facilities, etc., in retail business districts.

The ordinance provides for six classes of use and one class of special use districts, the latter divided into three parts; and for five height districts and also for five area districts. The six use districts are dwelling, apartment house, retail business, commercial, ordinary industry, and heavy industry; and the special uses are subdivided into obnoxious, indeterminate, and institutional. The limits in each of the height districts are 35, 50, 75, 105, and 136 ft. The area districts provide for the following number of square feet of lot area per family: 4,000, 2,000, 1,000, 500, and 310 sq.ft. On corner lots 10 per cent may be deducted from the area per family.

As to the building lines in residence districts, the commission states:

> The zoning plan also establishes building lines on all streets in residence districts and on some streets in business and industry districts to maintain front yards, along residence streets and to provide adequate distances between buildings required by traffic conditions and the anticipated height of buildings, in the interest of public health, safety, convenience, comfort and general welfare. In residence districts, the building lines established generally conform to the lines provided by deeds, allotment plats or the lines determined by 50 per cent or more of existing buildings. All building lines are shown on a separate set of maps which accompanies and is a part of the zoning ordinance.

The use, height, and area districts are all shown on a single set of maps consisting of twelve sheets, drawn to a scale of 400 ft. per inch.

For the foregoing information we are indebted to Charles F. Fisher, formerly engineer of the City Planning Commission of Akron, Ohio, and now engaged in zoning work at Providence, R. I., under the direction of Robert Whitten.

Sources of Error Occurring in Boundary Surveys

Precise Triangulation Prerequisite to Satisfactory Boundary Determination — Examples of Station Error in Astronomic Method

By C. V. Hodgson
Assistant Chief, Division of Geodesy, U. S. Coast and Geodetic Survey, Washington

THE methods of describing the boundaries of national territories and their subdivisions show only one advance through the centuries—that of using parallels and meridians as boundary lines. Nor have the engineering interpretations of those descriptions made the progress they should.

Notwithstanding the importance of the proper delineation of boundaries, there is lacking an established method of procedure, based upon proper engineering principles for locating boundary lines. The legal principles involved are simple, resting mainly upon the tenet of national law which provides that the boundary line between units of equal sovereignty be defined by mutual agreement of the powers concerned. Here no doubt lies the reason why a standard practice has not grown up for making boundary surveys, for no matter by what method the boundaries are located and marked, a boundary once legally agreed to by both parties will remain the boundary until modified by subsequent agreement.

Aside from the legal aspects, some interesting engineering questions are involved in determining boundaries when defined as being formed by a parallel or meridian, or by a straight line between two designated points. The question as to whether a boundary should be determined by astronomic methods, or a combination of astronomic and geodetic methods has more than academic interest to the parties concerned. Even the simple operation of running a straight line between two points on the earth's surface is not so elementary as it sounds, for C. A. Schott ("Oblique Boundary Line Between California and Nevada," report of Coast and Geodetic Survey for 1900, Appendix 3) pointed out in a mathematical discussion of the oblique boundary between Nevada and California that eight different so-called straight lines may be run between two points on the earth's surface. This condition is due to the fact that the deflection of the vertical at different points on the line varies, and the methods of making the backsight and foresight in lining out the boundary are different.

This station error is the deflection of the plumbline from the normal to the ellipsoid of mean surface of the earth caused by the variations in the density of the earth's crust. Its effect is to shift the observer's zenith.

Examples of Station Error—Some idea of the magnitude of the errors which may be introduced into determinations of geographical positions by this station error may be obtained by an inspection of the geodetic latitudes and longitudes of some state boundary monuments when determined by the precise triangulation of the Coast and Geodetic Survey. This triangulation is based on the North American Datum, which was adopted originally by the United States and later by Canada and Mexico as a triangulation reference datum and so chosen as to bring the continental area of the

United States into its proper geographical relation with the equator and the Greenwich meridian.

The arc of precise triangulation along the ninety-eighth meridian shows that the north boundary of the state of Kansas is nearly 880 ft. north of the fortieth parallel, while its south boundary is over 500 ft. south of the thirty-seventh parallel, its constitutional boundaries. Supposing that the relation between monuments and adjusted latitudes remains the same for the whole length of the state, the state is therefore ¼ mile wider than intended by its constitutional limits.

Triangulation also showed a boundary monument between Colorado and Wyoming to be almost 600 ft. too far south, a monument between South Dakota and Nebraska nearly 660 ft. too far north, the monument at the southeast corner of Montana 650 ft. too far south, and the monument at the northeast corner of Wyoming over 800 ft. too far south.

Longitudinal Discrepancies—The discrepancies in longitude are even greater than in latitude, due no doubt to the far greater difficulty in securing an accurate longitude determination. A boundary monument between Colorado and Utah is over 2,200 ft. too far west, according to its longitude on the North American Datum. One monument on the eastern boundary of Montana indicates that the boundary is almost 1,900 ft. east of its proper location, while another monument about 150 miles further south, on the same boundary and supposedly on the same meridian, is 3,300 ft. east of the proper meridian, defined as the twenty-seventh meridian west of Washington.

The boundary line marked between Nevada and Utah exhibits a similar divergence from a true north and south direction, for in latitude 39 deg. 10 min. a boundary monument supposed to be on the thirty-seventh meridian west of Washington is about 1,040 ft. too far east, while in latitude 41 deg. 20 min. it is nearly 3,300 ft. too far east. It should be stated that the distances given above are in round numbers.

These discrepancies between the astronomic and geodetic latitudes and longitudes, while large, are excelled in size by those found in other countries. As one of several examples that could be cited a relative discrepancy in geographic position was found between two astronomic stations in Turkestan 65 miles apart amounting to 76 seconds of arc—almost a mile and a half. This is an average error of 120 ft. to the mile. Again, in the vicinity of Dehra Dun, India, there is a total deflection of the vertical of 62 sec. of arc, and within five miles the change in the meridian component of the deflection amounts to more than 12 sec. of arc. In other words, the difference of latitude between the two ends of that five-mile line would be in error more than 1,200 ft. if determined astronomically.

It will be seen from the above that a boundary line located by astronomic methods will be seriously out of relation to the geographic position of the adjacent terrain as determined by a general system of triangulation, but an even more serious defect in its location is found in its zig-zag course, due to the effect of the change in the deflection of the plumbline along the boundary. Each astronomic station will have its zenith deflected in a different direction or amount from the preceding one, and the line carried forward will have its direction affected accordingly. This explains in part why two successive locations of a boundary never agree, for while two astronomic determinations of the geographical position of any one point will agree within one or two tenths of a second of arc (about ten to twenty feet) a line extended from that point for fifty miles to another astronomic position may show a discrepancy of several hundred feet in the position of the second point.

Where there is existing adjusted triangulation or a standard datum for horizontal control proper geodetic methods will give a boundary line which will meet the fundamental requirements that the boundary be in proper relation to geographical position to the adjacent territory as mapped, and also that all points on the marked line shall be on the meridian designated as the boundary, or on the arc of a great circle between the two points designated as the terminal points. No other location is satisfactory from an engineering or mapping standpoint though it may meet the legal requirements.

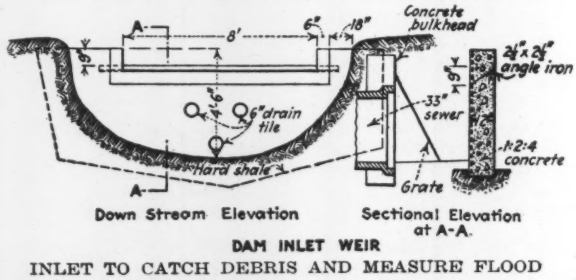
Satisfactory Boundary Determination—To secure this result two things are essential. The first is that the termini of the boundary arc be determined by precise triangulation and by it connected to the standard datum of the country. The second is that precise triangulation shall follow the boundary so closely that offsets can be measured from a sufficient number of triangulation stations to the boundary to define the boundary adequately. Before the offsets are measured the entire triangulation should be adjusted to the general control scheme of the country. The offsets can then be measured to the boundary according to the computed distances and directions, and the monuments tested visually for alignment.

The location of the boundary lines of a nation or of its subdivisions is of such prime importance that the methods used should correspond in accuracy to those employed on the most accurate control surveys.

Combined Dam, Sewer Inlet and Weir

BY R. E. SPEAR
Formerly Borough Engineer, Ambridge, Pa.

SPECIAL structures consisting of a combined weir, dam and inlet to measure the water during flood period, to hold back the debris that comes down the steep ravines and to act as an inlet to a sewer have recently been constructed in the hill sections of the Borough of Ambridge, Pa. The form is shown in the accompanying drawing. In one rain one of the structures held back 120 cu.yd. of debris, thus enabling the



DAM INLET WEIR
INLET TO CATCH DEBRIS AND MEASURE FLOOD

sewer inlet to function properly rather than being completely covered up and permitting debris to be carried to streets and property below. The average cost of construction is $60. Many times this amount has been saved in one season.

Zoning Progress in the United States

By Mary T. Voorhees
Division of Building and Housing, Department of Commerce, Washington, D. C.

ZONING regulations to control the use, and in the majority of cases also the height and area of buildings, in accordance with a practical plan of municipal development, have been adopted in 78 cities of the United States within the past few years. The police power of the state under which zoning ordinances are enacted is usually delegated to the city by the state legislature, although some cities have zoned under home rule provisions, which they believe to be a sufficient grant of power.

Twenty-five states and the District of Columbia have passed laws granting to their cities the right to zone. In some of these states, all municipalities, including counties, may zone, while in others only particular cities or classes of cities have been given this power. A number of states will place zoning enabling acts before their legislatures in 1923.

Large cities, particularly, have felt the need of this sort of municipal protection. At the present writing 75 per cent of the cities of over 100,000 population in the United States are zoned, or expect to zone shortly. However, the small cities and towns far outnumber the larger ones in zoning activity.

The first comprehensive zoning ordinance in the United States was enacted by New York City in 1916. The entire city was divided into zones or districts to each of which appropriate regulations of the use, the height and the area of buildings applied. Some cities have adopted ordinances limiting only property uses.

The accompanying table lists the state zoning laws and city ordinances thus far passed. The language of the act in each state law has been retained so far as is consistent with space limits. The writer will be glad to be informed of additions to this list.

STATES AND CITIES WITH ZONING LAWS AND ORDINANCES REVISED TO SEPT., 1922

"Comp." indicates a comprehensive zoning ordinance; "Use" means use districts or zones only. The last column gives the date the various ordinances were adopted.

CALIFORNIA—Any incorporated city and town may adopt zoning.		
Alameda	Comp.	1919
Berkeley	Use	1920
Coronado	Comp.	1920
Long Beach	Comp.	1921
Los Angeles	Use	1909, 1916, 1921
Oakland	Use	1919
Palo Alto	Comp.	1918
Pasadena	Use	1919
	Comp.	1922
Pomona	Use	1917, 1920
Sacramento	Use	1917, 1919
Santa Barbara	Use	1920, 1922
San Francisco	Use	1921
Turlock	Use	1918
CONNECTICUT—Applies to New Haven.		
DISTRICT OF COLUMBIA—Applies to Washington.		
Washington	Comp.	1920
GEORGIA—Applies to Atlanta, as amendment to city charter.		
Atlanta	Comp.	Ordinance with race districts 1922
ILLINOIS—Each city, village and incorporated town.		
Evanston	Comp.	1921
Glencoe	Comp.	1921
Oak Park	Comp.	1921
River Forest	Comp.	1922
Winnetka	Comp.	1922
INDIANA—All cities.		
IOWA—Cities of first class, including cities under commission form of government and cities under special charter.		
KANSAS—Cities of first class having pop. exceeding 20,000.		
Hutchinson	Comp.	1921
Wichita	Comp.	1922
LOUISIANA—Cities with pop. over 50,000		
MASSACHUSETTS—Any city or town.		
Brockton	Comp.	1920
Brookline	Comp.	1922
Milton	Use	1922
MICHIGAN—City and villages.		
MINNESOTA—Cities of first class and any city of 50,000 pop.		
St. Paul	Comp.	1922
MISSOURI—Every city having or attaining pop. not less than 200,000 and not more than 600,000; each incorp. city or town of 50,000 or less.		
Springfield	Use	1921
Richmond Heights	Comp.	1922
St. Louis	Comp.	1918
University City	Comp.	1922
NEBRASKA—All cities of metropolitan class.		
Omaha	Comp.	1920
NEW JERSEY—All municipalities		
Bogota	Comp.	1921
Bound Brook	Comp.	1921
Caldwell	Comp.	1921
Cliffside Park	Comp.	1920
East Orange	Comp.	1921
Glen Ridge	Comp.	1921
Hoboken	Comp.	1922
Irvington	Comp.	1922
NEW JERSEY—All municipalities.		
Jersey City	Comp.	1922
Maplewood	Use	1921
Montclair	Comp.	1921
Newark	Comp.	1920
Nutley	Comp.	1922
Paterson	Comp.	1921
Rahway	Use	1920
	Height and area regulations in residence district	1921
Roselle	Comp.	1922
Roselle Park	Comp.	1921
Rutherford	Comp.	1922
South Orange	Comp	1922
Verona	Use	1922
Westfield	Comp.	1921
West Orange	Comp	1921
NEW YORK—Cities not of the first class, and villages, and to New York and Rochester as amendments to city charters		
Bronxville	Use	1922
Gloversville	Comp.	1921
New Rochelle	Comp.	1921
New York City	Comp.	1916
Niagara Falls	Comp.	1920
No. Pelham	Comp.	1921
Rochester	Use	1919
Scarsdale	Comp.	1922
Syracuse	Use	1922
White Plains	Comp.	1920
Yonkers	Comp.	1920
NORTH CAROLINA—City planning law with zoning provisions applies to cities in the counties of Buncombe, New Hanover and Wake		
OHIO—Any municipality		
Akron	Comp.	1922
Cleveland Heights	Comp.	1921
E. Cleveland	Comp.	1919; 1922
Lakewood	Comp.	1922
OREGON—Any incorporated city and town.		
PENNSYLVANIA—Cities of the first and second classes.		
RHODE ISLAND—Any city		
SOUTH CAROLINA—Park commission law with zoning provisions applies to Spartanburg.		
TENNESSEE—All municipalities of pop. in excess of 160,000 in 1920.		
TEXAS—Cities or towns having pop. more than 5,000		
Dallas	Use	1922
	Race segregation	1916
UTAH		
Salt Lake City	Use	1920
VIRGINIA—Any city		
Richmond	Use	1922
WASHINGTON		
Tacoma	Use	1919
WISCONSIN—Every city, and any village in any county of pop. of 250,000 or more		
Cudahy	Use	1919
Janesville	Comp.	1922
LaCrosse	Use	1921
Milwaukee	Comp.	1920
Neenah	Use	1915
Racine	Use	1916

A Legal View of Fire Protection

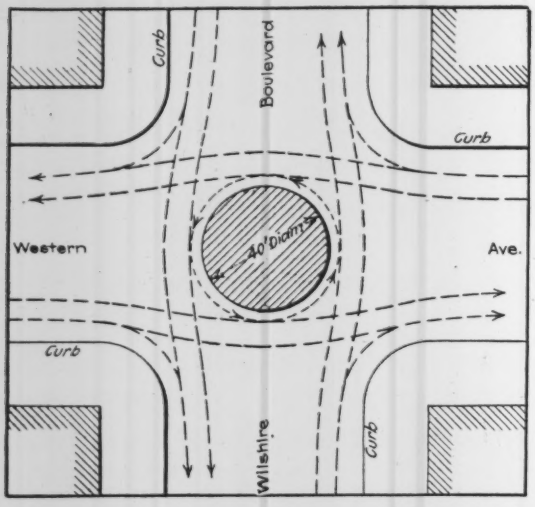
A decision recently rendered by the Court of Appeals of New York State in a case involving the mandatory installation of fire windows throws light on the attitude of the legal mind toward the technical questions of fire protection. The fire commissioner of New York City, under a provision of the city charter, ordered a building owner to provide certain windows in his building with metal or kalamein frames and sashes with wired glass and make them of self-closing construction. The owner sued to prevent the execution of this order, on the claim that such installation constituted a structural change. Rudolph P. Miller outlines the case as follows:

The question seems to hinge on an interpretation of the city ordinance which requires that "the owners and proprietors of all manufactories shall provide such fire hose, fire extinguishers, buckets, axes, fire hooks, fire doors, and other means of preventing and extinguishing fires as the fire commissioner may direct." By a previous decision of the Court of Appeals the fire commissioner has no authority under this provision to order structural changes. The lower court decided against the defendant, the Appellate Division reversed this judgment, and the Court of Appeals again reversed the Appellate Division. In confirming the judgment of the trial court, the upper court held that installations of the windows is not a structural change. In explaining this decision the court of last resort said (italics ours):

"So far as the window frames or sashes are concerned, defendant could comply with the order of the fire commissioner *by painting or coating them with a certain kind of fireproof mixture.* This involves no structural change. The same is true of the requirement for wired glass in windows. A window pane is of such fragile and therefore temporary and changeable character that we do not think that anybody would regard it as a part of the permanent construction of the building as would be an elevator, a chimney, or a wall. The feature of making the windows self-closing is a matter of detail involving the use of some simple device, and certainly would not involve anything more in the way of permanent construction than would the appliances which are attached to an ordinary fire door causing it to close when fire approaches."

Traffic Circle Relieves Crowded Street Intersections

A METHOD of traffic control for relieving congestion at street intersections has recently been put into operation in Los Angeles by Major John A. Griffin, city engineer who states that it has clearly demonstrated itself to be capable of handling up to 5,000 vehicles per hour without the aid of a traffic officer. The timing of vehicles by stop-watch as they entered the apparent congestion in the double line of traffic revolving around the circle, according to Major Griffin, showed that even



TRAFFIC CIRCLE AND LINES OF TRAVEL

loaded trucks with trailers would go through the intersection and be clear in slightly less than a minute. Ordinary cars took about 40 sec.

A 40-ft. circular enclosure is laid out in the center of the intersection so that all machines must turn to the left striking the line of traffic obliquely instead of at right angles. This has the effect of causing each machine to turn in behind the machines already using the crossing and the rotation of the entire mass provides for 100 per cent utilization of the roadway, whereas with a traffic officer on the intersection only 50 per cent of the roadway can be used at any one time.

When the traffic circle was tried out it received much adverse comment from those who saw it for the first time. However, actual experience with the plan, Major Griffin asserts, proves that there is not as much confusion as would at first appear because each machine continues to move toward its objective.

Radio on the Salt River Project, Arizona

A radio broadcasting station has been installed to facilitate the operation of the Salt River Irrigation Project. The *Reclamation Record* for August reports:

Gages are placed in the upper Verde and also at Cave Creek, so that any appreciable rise of water caused by sudden storms can be noted and broadcasted from the station to the manager's office in Phoenix and to all ranch owners who listen in, thus providing a timely warning and preventing great damage. The inlet from the reservoir at Roosevelt Dam will also be controlled by telephone from Phoenix, based on reports from the radio station; thus it will be closed when there is a sufficient water supply and opened when the water in the river is low.

Revamped Sewage Disposal Plant at Chicago Heights, Ill.

Contact Bed Replaced by Sprinkling Filters Dosed From Tanks Having Rotating Slide Valves—New Electric Driven Pumps

BY L. K. SHERMAN
President, Randolph-Perkins Co., Consulting Engineers, Chicago

IN THE remodeled sewage-works of Chicago Heights, Ill. (Fig. 1), the original contact beds have been changed into sprinkling filters, pumps installed to give the requisite head and a novel rotating slide valve apparatus devised to vary the head and quantity fed to the sprinkling nozzles.

Chicago Heights has a population of 20,000, the greater part of which is served by separate sewers. The sewage was treated for several years by septic tanks and contact beds but the beds clogged and became ineffective. Recently the city completed the remodeling of its sewage-works, utilizing so far as possible the old plant. The four contact beds, with a total area of one acre, were changed to sprinkling filters equipped

FIG. 1—CHICAGO HEIGHTS SEWAGE-WORKS

Old contact beds changed to sprinkling filters. Former syphon dosing chamber converted to combined pump house and rotating slide-valve dosing apparatus, supplying beds alternately with variable head on sprinklers.

with 400 Taylor nozzles. Remodeling the old works into an activated-sludge plant would have cost 20 per cent less but the annual cost would have been more than twice that for sprinkling filters.

Since the available gravity head was insufficient to operate sprinklers, additional head is secured by means of two float-controlled, electrically-operated centrifugal pumps. The flow of sewage varies from 300 to 3,000 g.p.m. One pump has a capacity of 1,000 and the other of 3,000 g.p.m. The pumps are set in the same sump and are direct-connected to their respective motors by vertical shafts. The old house which held the siphons for dosing the contact beds was remodeled into a pump station.

The novel feature of the new installation is the intermittent, variable dosing apparatus shown in Figs. 2 and 3. The pumps discharge through separate pipes into a steel dosing tank 4 ft. in diameter and 9 ft. high. Each discharge pipe is provided with a back-pressure flap valve. In the bottom of the tank are four 10-in. pipe outlets, placed 90 deg. apart. Each outlet supplies the sprinkler system of one of the four filter beds. A vertical shaft in the center of the tank is

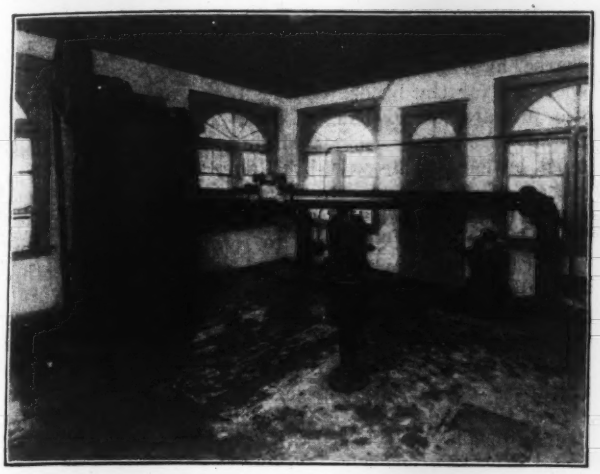


FIG. 2—DOSING TANK AND TOP FLOOR OF PUMP HOUSE

Rotating slide valves connected with shaft driven by ½-hp. motor at left of tank control four outlets in bottom of tank (below floor). Each outlet supplies one sprinkling filter.

turned by a worm gear on top of the tank, driven through belt connection by a ½-hp. electric motor. The vertical shaft carries two plates, or slide valves, each having an arc of 90 deg., placed opposite each other. (Only one valve is shown in Fig. 3.) The valves are geared to make one revolution in 30 minutes. As the slide valve passes one of the 10-in. ports the sewage begins to flow out at an increasing rate until full opening. At the same time the sprinkling nozzles of the bed supplied by that port gradually increase the radius of their spray until they cover a diameter of 11 ft. The flow continues for 8 minutes, when the radius of the spray gradually decreases, comes to a stop and that particular bed rests for 8 minutes. The period between partial and full discharge of the nozzles can be increased to any desired extent by making the edge of the rotating valve on a diagonal instead of a vertical line.

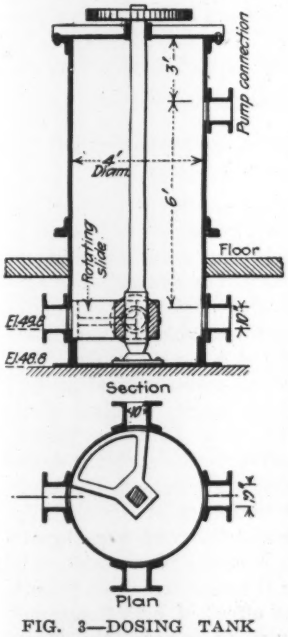


FIG. 3—DOSING TANK

Only one of the two valves is shown. Two beds dosed together normally. Any bed may be thrown out of use by closing valve on supply pipe.

When the larger pump is in operation and when two ports are at full opening, the other two are closed and 100 nozzles on each of two beds are at full spray. With the smaller pump in operation, any two adjacent beds are cut out by closing two gate valves on these beds. About one-third of the nozzles are also cut out by two gate valves in the two operation beds. The cycle of dosing and rest then takes place alternately upon the two beds in service. The maximum head at the nozzles is 2.7 ft. for operation with either pump. The total head, including friction losses, or height of water in the dosing tank, ranges from 4 to 6 ft. above the nozzles.

Normally the smaller pump is sufficient. When the sewage flow is more than 1,000 g.p.m. the four gate valves in the beds are opened, the current is shut off the smaller pump and the large one started. This is the only manual operation required. The city, however, keeps a man on duty at the sewage works to rake off the screens, keep the nozzles clear, regulate flow in the settling basins, handle the sludge, act as watchman and generally follow instructions and keep records for the efficient operation of the plant.

The new works and dosing apparatus was designed by the writer and the construction supervised by M. H. McCoy, city engineer. William F. Hildemann, Chicago Heights, Ill., was the contractor.

Experiment in Asphalt Paving at Philadelphia, Pa.

Base Roughened by Slag Spread on Green Concrete and Slightly Pressed In—Large Stone Used in Binder Course

By Julius Adler
Deputy Chief, Bureau of Highways, Philadelphia, Pa.

With the outlook promising traffic of increasing severity on Philadelphia streets, it was felt this year that the time had arrived to try out in an experimental way some changes in the make-up of an asphalt pavement which would be more far-reaching than the ordinary variations which are supposed to distinguish light- and heavy-traffic mixtures.

Since 1917 the prevailing practice in Philadelphia has been a 1½-in. surface with 1 in. of close binder. Previously a 2-in. surface course had been used. A careful examination made about three years ago of these pavements failed to show a clear relationship between the condition of the pavements and the variations in composition which have usually been considered as being influential in this respect, and there was little to suggest that a general improvement in the condition of pavements in Philadelphia could be effected by a closer control of the paving mixtures from the standpoint of composition.

It was decided that the logical procedure was along other lines than varying the composition and as an experiment, contract has been entered into for repaving 22nd St., from Locust to Fitzwater Sts., situated on the edge of the central business section and carrying heavy one-way traffic, principally on one shoulder. The street is 32 ft. wide, with a single car track in the center, and the improvement consists of smooth dressed granite blocks between the rails and for runners, and sheet asphalt shoulders. The base is a 1:3:6 cement-concrete, 6. in. thick.

As the basis for arriving at the specification changes, it was concluded that in the creeping and pushing of asphalt pavements, two principal factors are to be contended with; (1) movement of the entire pavement on the surface of the foundation, and (2) insufficient stability or rigidity in the pavement itself.

In numerous instances, it has been found that asphalt pavements have moved bodily on the foundation and this has been attributed to the fact that under heavy motor traffic the thrust imparted to the asphalt has not been transmitted through the surface to the foundation in a path sufficiently short to prevent buckling. Under the condition here assumed the asphalt pavement takes

on some of the characteristics of a horizontal column of uncertain length, which deflects under the horizontal component of thrust from the traffic. The attempted method of solution of this difficulty, which is to be employed in the project under discussion, consists in making the surface of the concrete base of such character as to provide almost immediate means of transmitting horizontal stresses from the asphalt pavement to the rigid foundation.

In the matter of increasing the stability of the surface mixture, the general scheme to be employed is to reduce the thickness of the surface course, which is considered to be the least stable portion of the pavement, and to increase the rigidity of the binder course as later described.

Base Surface Rough—The first innovation in the specifications is to produce a determined uniformly rough surface to the concrete as contrasted with such accidental roughness as commonly occurs in the finishing of concrete base, and which varies greatly with the character of aggregates used and the method of manipulation.

The concrete when deposited is to be of the usual quaky consistency and is to be "spread and compacted as required to bring it to a true surface free from irregularities, depressions or marked surface voids." Shortly after the concrete has been deposited, but before initial set has taken place, there is to be cast over the surface 1½ in. crushed stone or crushed slag, which is to be lightly rammed into the concrete so as to be firmly imbedded, with the points projecting from ½ to ¾ in. above the original surface of the concrete. To insure uniformity, it is further required that the peaks of the projecting points will be separated by an average distance of 1½ to 2 in. but not to exceed 4 in. and the surface must be preserved in this condition until the asphalt binder course has been laid. Roughening the surface by the use of toothed rakes or any similar substitute method will not be permitted.

As previously stated, the roughening of the concrete surface is intended to form a mechanical bond or key between the asphalt surface and the foundation so that horizontal forces will be promptly and uniformly transmitted from the asphalt to the concrete. On one section of this contract, the concrete foundation is to be finished in accordance with the city's standard specifications.

Thin Top Surface—In the matter of increasing the stability of the asphalt pavement, the initial step is the reduction of the thickness of the surface mixture to the minimum practical, namely 1 in. For the binder course it was believed that the best available method of increasing the stability lies in employing a coarse aggregate of larger average dimension than that usually used. The specification therefore provides for the use of a well-graded coarse aggregate, ranging from 2 in. maximum diameter down to approximately ¼ in. This mixture will be a close binder containing from 4½ to 6½ per cent by weight of bitumen, 15 to 25 per cent of sand, and the remainder coarse aggregate. In proportioning, the attempt will be made to produce as dense a mixture as possible without developing a surface under the roller which will be so smooth as to reduce the bond between the surface mixture and the binder course.

In the matter of size of aggregate, it may be noted that in the construction of the Byberry and Bensalem Service Test Road in Philadelphia, in 1912, there was included a section of asphaltic concrete in which the coarse aggregate used was a trap rock of the size specified for the binder course in the present case. In the preparation of this mixture at the plant, it was found that mixer blades slightly shorter than usual must be used to prevent breakage, as a result of large pieces of the aggregate being wedged between the blades and the liner plates; and moderate temperatures must be employed in order to retain a proper coating of bituminous mortar on the large stone. No other difficulty whatever was experienced in the use of this material and this section of pavement is still notably free from waves.

Binder Course 2 in.—Accompanying the decrease in thickness of surface course, and the increase in the size of the binder aggregate, the thickness of the binder course has been increased to 2 in. Allowing for the usual wedge-shaped character of the aggregate and the fact that the fragments almost invariably bed themselves on a flat face after the roller has passed over, it is not anticipated that there will be any appreciable number of single pieces of aggregate extending from the surface to the bottom of the binder course.

The 1-in. surface course is considered the least depth practicable to rake and roll as a course separate from the binder. Provision is also made for the use in this surface mixture of not to exceed 25 per cent by weight of clean trap rock chips, with a view of effecting some stiffening, but the exact amount to be used will be determined by weather conditions at the time the work is done. In the event of cold weather a surface mixture with the maximum amount of stone, and 1-in. in thickness, would be subject to excessive honeycombing.

For purposes of comparison the lower portion of this contract, as previously mentioned, will have a concrete foundation laid and surfaced according to the usual specifications and on this section, the asphalt pavement to be laid will consist of 1½-in. binder and 1½-in. surface mixture with no deviations from ordinary specifications in either case. Work under this contract is scheduled to begin in the latter part of September.

Chemical and Atmospheric Corrosion Differ Bureau of Standards Shows

Recent comparisons of tests on alloy steels at the Bureau of Standards have shown a decided difference in comparisons based respectively on chemical and on atmospheric corrosion. In tests where hydrochloric acid was used as corroding agency, the most resistant materials were a high nickel-chromium steel, invar, pure iron, and medium carbon steel very slowly cooled from a high temperature. The acid attacked a steel at 13.7 per cent chromium content much more rapidly. However, in atmospheric corrosion (test made by partial immersion in water and exposure to the air) the order of resistance of these materials was reversed, the high-chromium steels resisting the action most successfully, while the low-chromium steels and the pure iron showed rust spots early in the test. Nickel and chromium in combination appeared to make the steel resistant to both acid and weather attack. The effect of heat treatment was found to be minor, though in general the steels which were quenched resisted corrosion better than annealed samples.

Street Cleaning Methods and Costs at Akron, Ohio

Hand and Machine Methods Compared—Sidewalks Flushed by Tank Wagons—Quantities, Costs and Performance Given

By Frank C. Tolles

Superintendent, Bureau of Public Works, Akron, Ohio

STREET cleaning costs for the year 1921 together with a brief notation of methods and of the manner in which the data are gathered and compiled are here presented for Akron, Ohio.

Akron is estimated to have a population of 165,000. It covers an area of 25 square miles and has about 160 miles of surfaced streets—chiefly brick. Street cleaning is performed by city forces and is paid for from special frontage assessments. The assessment rates range from 5c. to 60c. per front foot per annum. The rate is made dependent upon the frequency of cleaning.

An average force of 85 men and 16 pieces of motor apparatus is employed. The total cost for 1921 was $127,195.17. The equipment includes three pickup sweepers, one gutter sweeper, two flushers, one catch basin cleaner, seven two-ton trucks, one service car and one roadster.

Work Reports—As the basis for levying assessments and to enable costs to be determined, the foreman of each gang and the operator of each piece of equipment submits in form a daily statement of the streets covered. In the case of mechanical equipment there are also included data as to gas and oil consumption. The garage reports and purchase orders furnish information as to repairs. The street mileage is secured for each day by means of a map scale and is converted into square yards by applying the average width of Akron paved roadways, 23.8 ft. The resulting yardage is listed as the performance of the equipment; it is a nominal performance and departs from the true in variable amount. Flushers for example cover the full area, whereas motor sweepers normally broom but a 7-ft. swath on each side of the street, or about 60 per cent of the pavement area. In all cases, however, instructions call for leaving the street clean and adherence to orders is insured by inspection. The clerical work resulting from this procedure is slight.

Methods of Cleaning—The methods of cleaning include hand brooming—by gangs or by patrol—flushing, and motor sweeping. The business area is cleaned at night. The difficulty encountered from the practice of sweeping out stores and walks in the morning after the roadway has been cleaned is met by sidewalk flushing. This work is necessarily confined to summer months and is patterned upon Chicago methods. Two horse-drawn, pressure flushers each of 700 gal. capacity are used. They are equipped with hose attached to a gooseneck swivel at the top of the tank. A driver and two men serve each flusher. The results are shown in Table I.

TABLE I—SIDEWALK FLUSHING, PERFORMANCE AND COST, AKRON, OHIO, 1921.

Performance		Cost	
Days operated	125	Labor and team hire	$4,182
Sq.yd. flushed	4,362,000	Water allowance	261
Gal. water per M. sq.yd.	375	Supervision	350
Sq.yd. flushed per gang per hr.	2,180	Capital charges	100
			$4,893
		Cost per M. sq.yd.	$1.12

Tables II, III and IV present summary costs covering handwork and mechanical cleaning.

	No 62 Pickup Sweeper Gutter Broom Attached 1920 Model			No 73 Pickup Sweeper Gutter Broom Attached 1920 Model			No 74 Pickup Sweeper without Gutter Broom 1916 Model			No 75 Gutter Sweeper 1920 Model		
Performance												
Number of days operated	222			205			165			176		
Number of hours operated	1702			1362			1095			1253		
Street cleaned - 1000 Sq. Yd.	17809			23658			12107			12489		
Dirt removed - Cu. Yd.	2478			3173			1691			–		
Costs												
Driver-Wages		$1414.00			$1058.00			$849.11			$831.45	
Helper-Wages		549.90			508.65			389.00			–	
Gasoline and Oil		637.11			536.05			364.53			289.97	
Total Operating			$2601.01			$2102.70			$1602.64			$1121.42
Repairs - Wages		711.68			614.12			865.52			512.09	
Repairs - Parts		585.31			488.76			882.04			776.70	
Total Maintenance			1296.99			1102.88			1747.56			1288.79
Tire Cost		–			–			–				–
Depreciation @ 5 Yr.		1192.26			1092.79			828.00			720.00	
Interest @ 5%		331.19			303.55			230.00			200.00	
Total Capital Charges			1523.45			1396.34			1058.00			920.00
Total Cost			5421.45			4601.92			4408.20			3330.21
Units												
Cost per 1000 Sq. Yds.			0.304			0.195			0.36			0.267
1000 Sq. Yds. per Hour	1046			1737			1105			995		
Cu. Yds. Dirt per 1000 Sq. Yd.	0.139			0.134			0.140			–		

Cost of Motor Sweeping (Pickup Sweeping Only) ..... 53,574,600 Sq. Yd.

Machine Cost	$ 14,431.57
Pickup Truck @ 0.60/Cu. Yd.	4405.20
Pickup Labor, estimated	1,230.00
Garage Rental (allow)	1,600.00
Overhead	2,980.00
Total	24,646.77
Per 1000 Sq. Yd.	0.46

TABLE II—SUMMARY OF COSTS ON MOTOR SWEEPING IN AKRON, OHIO. COVERING 53,574,600 SQ. YD.

	Truck No. 42 1917 5 Ton White Chassis 1200 Gal. Studebaker Tank Auxiliary Motor for Pump			Truck No. 71 1919 5 Ton White Chassis 1500 Gal. Studebaker Tank Auxiliary Motor for Pump		
Performance						
Number of days operated	185			245		
Number of hours operated	1,783			2647		
Water—Million Gallons	5.795			11.142		
Street Flushed—Thousand Sq.Yd.	12,176			23,537		
Costs						
Driver—Wages		1176.69			1901.46	
Helper—Wages		—			—	
Gasoline and Oil		1002.69			1844.90	
Total Operating			2179.38			3746.36
Repairs—Wages		740.80			555.17	
Repairs—Parts		590.52			422.29	
Total Maintenance			1331.32			977.46
Tire Cost			178.19			
Allowance for Water			930.00			1788.00
Insurance			174.25			171.25
Depreciation @ 5 Yrs.		1223.46			1529.58	
Interest @ 5%		339.85			424.89	
Total Capital Charges			1563.31			1954.47
Total Cost			6356.45			8640.54
Units						
Cost per 1000 Sq.Yd. Flushed			0.522			0.367
Gals. Water per 1000 Sq.Yd.	476			473		
Sq.Yds. Flushed per Hour	6,580			9,610		

Cost of Flushing 35,713,000 Sq.Yd.	
Machine Cost	$14,996.99
Garage Rental Allowance	1,000.00
Overhead	1,610.00
Total	17,606.99
Per 1000 Sq.Yd.	0.493

TABLE III—COST OF FLUSHING 35,713,000 SQ.YD

Using 5-ton trucks fitted with either 1,200 or 1,500-gal. tanks the unit cost is found to be 0.493 cents per 1,000 sq.yd.

A summary of performance subdivided as to method is shown in Table V. This table does not include sidewalks flushing, catch basin cleaning, collection of paper from waste receptacles, snow removal or clearing pavements of debris resulting from extraordinary storm water wash—all these items being under division control.

TABLE V—SUMMARY OF STREET CLEANING COSTS AT AKRON, OHIO, 1921

Method	Sq.Yd. Cleaned	Per Cent of Total	Cost per 1,000 Sq.Yd.
Hand sweeping (gangs)	37,378,600	24.1	0.98
(station)	15,748,600	10.2	0.81
Flushing	35,713,000	23.1	0.49
Motor sweeping	66,063,000	42.6	0.42
	154,903,200	100.0	0.61

Comparison of Methods—It is not practicable to eliminate hand cleaning. The practice locally is to concentrate most of the work into eight or nine months of the year. The amount of dirt on the streets after spring thaws is too heavy for the brooms; it must be removed by hand. The best results in residential areas are secured from alternate sweepings and flushing according to schedule. It is found less expensive and more satisfactory to clean periodically than to await littering of the street.

The flushers in use are of the two-unit type, and operate under 40 to 60 lb. pressure. It is difficult to maintain the auxiliary motor in working conditions, but the results are more satisfactory than when a single power plant is used. Although many pavements are built upon a sand base, pressure flushing has not been found to have an adverse effect. All division of street cleaning activities are under the control of H. R. Russell as superintendent. E. A. Zeisloft is Director of Public Service.

Hand Sweeping—Gang Work					1921	Hand Sweeping—Station Men			
Days Wk'd	Man Hours	1000 Sq.Yd. Cleaned	Cost Labor	Cost Foreman	Month	Days Wk'd	Man Hours	1000 Sq.Yd. Cleaned	Labor Cost
25	3133	1,066.2	$ 1,649.05	$ 360.00	Jan.	27	2113	2,288.6	$1,228.80
22	3892	1,493.6	1,930.10	399.75	Feb.	27	2027	1,662.7	1,296.15
27	4592	1,537.0	2,206.50	470.10	Mar.	30	2206	2,523.6	1,623.27
26	4843	2,408.0	2,252.80	456.95	Apr.	30	2780	2,570.7	1,572.02
26	3601	2,716.6	1,426.09	459.85	May	31	2878	2,520.9	1,203.40
26	6147	4,853.1	2,446.00	565.90	June	30	840	715.4	336.00
28	5575	5,350.7	2,229.60	616.75	July	31	758	658.6	309.60
27	5888	4,818.8	2,355.20	637.30	Aug.	31	828	630.5	331.20
26	5107	5,398.9	2,050.00	626.40	Sept.	25	974	1,202.0	438.60
27	2175	3,679.0	903.75	637.45	Oct.	31	630	390.4	252.00
25	1644	2,731.2	657.60	622.50	Nov.	30	619	481.5	247.60
24	995	1,325.5	398.00	99.60	Dec.	30	214	103.7	85.60
309	**47592**	**37,378.6**	**$20,504.69**	**$5,952.55**	**Totals**	**353**	**16867**	**15,748.6**	**$8,924.24**

Labor	$26,457.24	Labor	$8,924.24
Pickup @ 0.60/c.y.	9,000.00	Pickup (estimated)	3,230.00
Overhead	1,275.00	Overhead	530.00
Total	36,732.24	Total	12,684.24
Per 1000 Sq.Yd.	0.983	Per 1000 Sq.Yd.	0.806

TABLE IV—SUMMARY OF COSTS OF HAND SWEEPING AKRON STREETS

It has not been found practicable to do away with hand cleaning. Winter weather litters streets that are difficult to clean mechanically. Cleaning by gang costs 0.983 cents per 1,000 sq.yd., and by Station men 0.806 cents.

How Portland Supplies Water Outside City

The terms under which the city of Portland, Ore., stands ready to supply water outside the city limits have been formulated by the Bureau of Water-Works, of which L. S. Kaiser is superintendent. On petition, and after making estimates of costs and revenues, and finding a given project feasible, the bureau will contract for water with (1) the council of an incorporated country town; (2) with country residents who by vote form a water district under which the property benefited is assessed for first cost of the improvement; and (3) with regularly organized water companies. In any one of the three cases the party contracting with Portland for water has to build a main up to the city line and install a water meter there to measure the entire volume of water supplied by the city. As a rule, the outside water authority requires individual users to provide meters. The meter rate per 100 cu.ft. charged by Portland for water sold outside the city is 16⅔c. for the first 600 cu.ft.; 12½c. for the next 20,000 cu.ft., and 10c. for all above 20,000 cu.ft. The city charges a minimum of $1 a month for each town, district, or company which it supplies.

Road in Inaccessible Canyon Built by Novel Method

Grading Job in Oregon Done Speedily by Laying Out the Work in Successive Stages for Power Shovels of Different Sizes

IN BUILDING a road twenty miles long up the Clackamas River in Oregon to the site of the Oak Grove power development which is being undertaken by the Portland Railway Light & Power Co., it was necessary to follow the steep banks of the stream through a narrow valley in a region so rough and inaccessible that construction equipment could be gotten to the proposed line only at the lower end. By operating in the usual way, however, at one end of the work only, the desired speed could not be made and consideration was given to gettig small power shovels up the river on barges so grading could be carried on simultaneously from several different points. A still better plan was finally worked out whereby a small gas-electric shovel was advanced very rapidly over the proposed route, followed by a similar shovel that widened the roadbed and was in turn followed by still other shovels of standard size that could handle the heavier grading in the most economical way.

TYPICAL CONDITIONS MET BY GAS-ELECTRIC SHOVELS

Brush and timber were removed and narrow roadway built ahead of gas shovels. Wagon used for hauling dynamite has 3½-ft. gage.

The first step was to clear the right of way and at the same time to grade by hand methods a trail wide enough to accommodate a wagon with a 3½-ft. tread. Two such wagons were built and used to convey supplies to the clearing camps maintained ahead of grading operations. The first gasoline-electric shovel began at the lower end of the work and did just enough excavation to enable it to move ahead. In this way, by working three eight-hour shifts, it was advanced 8½ miles in 2½ months, through extremely rough country, leaving a roadbed for the most part about 8 ft. wide. The crews ahead of this shovel, in addition to clearing the right of way, blasted rock ready for excavation, using heavy charges so as to facilitate handling with the ¾-cu.yd. dipper. Tractors working behind the shovel were used to remove stumps and operate graders and scrapers in surfacing the roadway across flat country.

The second gasoline-electric shovel was started out immediately after the first, but was expected to handle more yardage and make slower progress. It cut the grade to the prescribed 5 per cent maximum and increased the width of the bench cut to 14 ft. except where long slides or excessively heavy grading was encountered. Steam shovels of standard size came last and completed the work, handling the bulk of the yardage where the cuts were deep and heavy.

Gas-electric shovels were selected for the advance work because of their small size and light weight, the low haulage cost on fuel of this grade and also because of the low fire risk. Because the line traverses heavily timbered country, during the summer season the fire risk was an important consideration.

At first the light for night work was supplied by a generator driven by the main engine on each gas-electric shovel. As this left the work in darkness when the main unit was shut down for repairs or for other reasons, a separate lighting system was provided, consisting of a Delco storage battery set mounted on a sled. From this leads were run to projectors and lamps placed on the shovel or to convenient points scattered about the work.

Only two men were regularly employed on each gas-electric shovel crew, one of these operated the control mechanism while the second acted as helper and made himself generally useful on the ground. The advanced shovel, working three 8-hour shifts, advanced at times as rapidly as 15,000 ft. in twenty days.

The work was taken over under the present contract on May 8. Two and a half months later the first shovel had progressed 8½ miles; the second, a similar piece of equipment doing more extensive grading, had advanced 4½ miles, and the heavy work was being handled effectively by the steam shovels. The last operation in the construction of the road is to be the placing of a 15- to 18-in. rock base covered with crushed rock and rolled with 10-ton steam rollers.

GAS-ELECTRIC SHOVEL WIDENING NARROW ROAD

This was the advance shovel, whose function was to make speed. Over a period of 20 days it made average daily progress of 750 lin.ft. in 24-hr. day.

The plan of construction by successive stages was worked out by the Hurley-Mason Co., contracting engineers, Portland, Ore., who are constructing the road under contract for the Portland Railway Light & Power Co.

Placing Concrete By Several Methods on Same Job

Chuting, Batch Boxes Moved by Crane and on Trucks and Buggies All Needed in Building New Bridge at Bethlehem, Pa.

IN the construction of the Hill to Hill bridge at Bethlehem, Pa., a structure being erected under the supervision of the Bethlehem Bridge Commission by Rodgers & Hagerty, New York City, the concreting plant layout is such that concrete can be chuted to piers and arches on practically all of the work. However, at the extreme ends of the three main approaches and at other more or less inaccessible points, other methods of handling concrete had to be devised. In all, four methods are used.

Mixing Plants—The bridge proper is about 2,000 ft. in length but with the approach ramps and the three main approaches this length is extended to about 6,000 ft. By referring to the accompanying figure the difficulty of devising one system to handle all concreting work is apparent. To handle the heaviest portion of the concreting both in piers and arches, the chuting system as indicated in the accompanying figure was devised. Inasmuch as the two mixing plants (also indicated in the figure) were utilized to mix for tranportation to those portions of the bridge inaccessible by chuting, large capacity mixing plants were required. Each of the two concreting plants was fitted with two 1-yd. mixers, a sand bin holding about 400 cu.yd., a stone bin of 800-cu.yd. capacity and cement sheds holding approximately 1,000 bags each. Sand and stone is clamshelled from stockpiles at the mixing stations into the bins.

Handling concrete by chutes is carried on with little difficulty and as many as 600 batches were chuted an average distance of 400 ft. during a ten-hour day. The chuting plant consists of three towers one 160 ft., another 240 ft. and the third 200 ft. high and approximately 3,500 lineal ft. of chuting of various types. In addition approximately 18,000 ft. of cable guys and chute supports are needed. Cable guys are of ⅝-in. and the chute supports 1¼-in. steel cable.

The second method of placing concrete was used at the south approach and will be used on the approach ramps at the southern end of the bridge. A locomotive crane which had been used in excavating for piers and abutments at the south approach was also used in handling concrete batch boxes from trucks to placement points in piers and abutments.

Handling Concrete by Truck—For other points, concrete is handled by batch boxes hauled in trucks from the two mixing stations. Each truck usually carries two 1-yd. steel batch boxes, except in those instances where spilling outside the forms is not feared. In that case larger batch boxes are used. Where possible these batch boxes are handled direct by derrick from motor truck to pier forms. This method was possible on piers just outside the radius of operation of the 200-ft. tower on the northeast approach. On the southeast approach concrete is handled first by batch box and truck, then dumped to an inclined material bin and transported to place by concrete buggies.

A feature of this job is the use to which stiff-leg derricks with 80-ft. booms are used as anchorage points and redistribution towers for the chuting system. The derricks were mounted on 40-ft. timber towers. The utility of such a scheme is fully recognized by referring to Fig. 2.

Materials and Their Procurement—Approximately 107,000 cu.yd. of concrete will be placed in the entire structure. Of this the amount in footings and piers will be about 46,000 cu.yd. and the rest in the superstructure.

All cement is trucked from Bath and Allentown, Pa. So far the contractor has discovered that cement costs less by using this method of transport than by the rail-

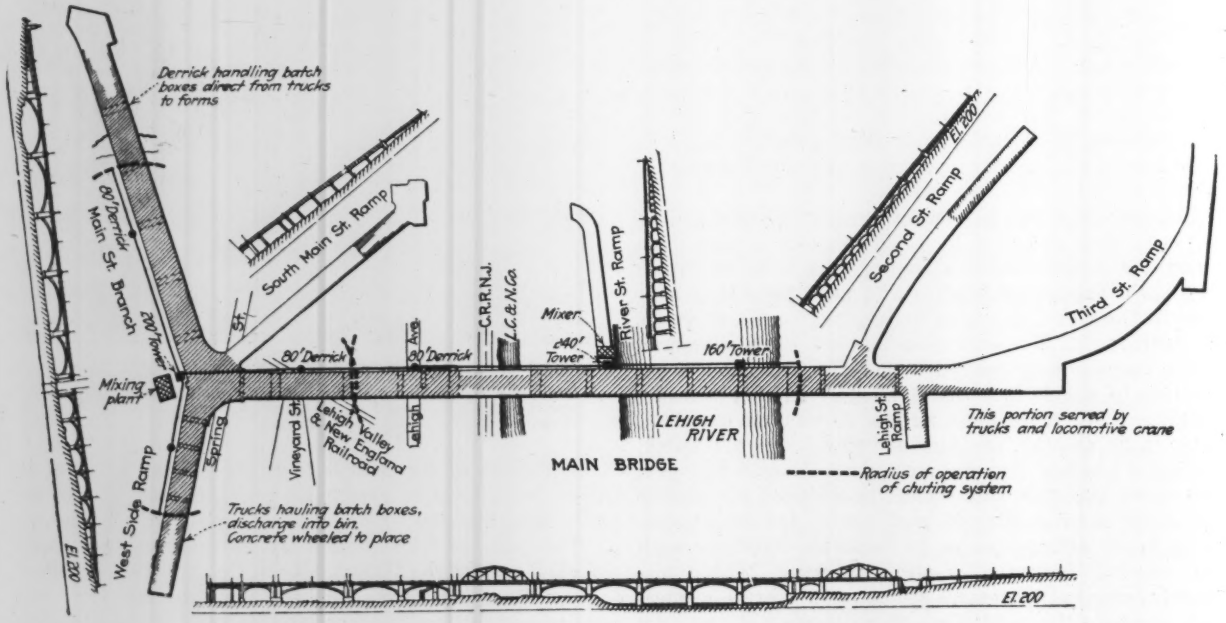


FIG. 1—PLAN OF BRIDGE SHOWING METHODS OF CONCRETE PLACEMENT USED

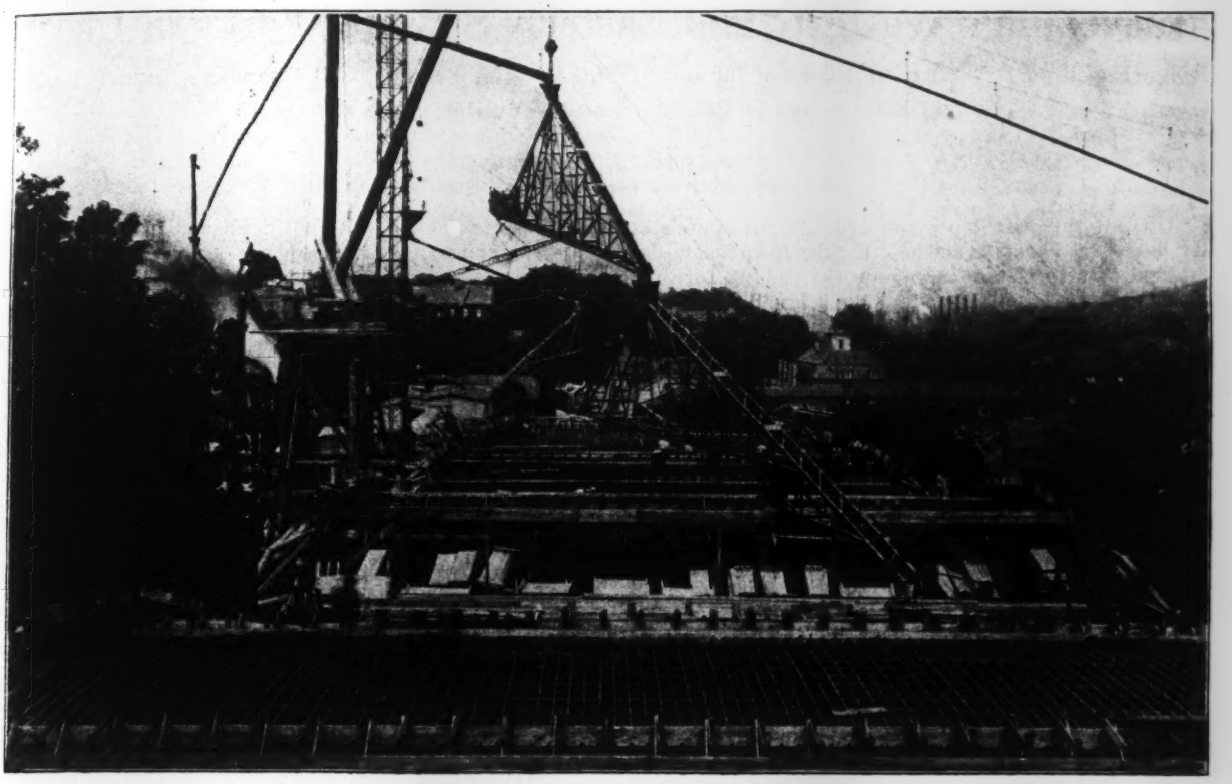


FIG. 2—STIFF LEG DERRICKS MOUNTED ON 40-FT. STAGING ARE REDISTRIBUTION TOWERS

road. Rehandling charges necessitated by rail haul is a saving the trucks effect.

The contractor has opened his own stone quarry about a mile and one-half from the bridge site. There is being operated a quarry face about 70 ft. high and with a length of 200 ft. Three crushers have been installed, a primary jaw crusher 24 x 36 in. and two secondary gyratories. The smaller of the secondary crushers is used for crushing screenings. There is a scalping screen used from the jaw to the gyratory crushers for removing the dirt from the stone. About twenty men are employed in the quarry and it is estimated that 100,000 tons will be used from this quarry.

Clarence W. Hudson is the designer of the bridge and consulting engineer to the Bethlehem Bridge Commission. H. J. Finebaum is resident engineer for the Commission. W. Caccia is resident engineer for Rodgers & Hagerty, the contractors, with George Angel as general superintendent.

The cost of the bridge will be in the neighborhood of $2,500,000. It will be completed early in 1924.

Health Ministry Rules for Refuse Tips

Suggestions for preventing nuisances at municipal refuse tips have been formulated by the British Ministry of Health. The main point of the suggestions are that refuse be tipped in layers which should not exceed 6 ft. in depth, and should be covered wherever exposed to the air with "at least 9 in. of earth or other suitable substance"; that reasonable precautions should be taken to prevent the breeding of flies, the breaking out of fires, or the blowing about of paper, etc.; and that so far as practicable each layer of refuse should be given time for settlement before another is added.

Relative Durability of Native Wood

A TABLE showing the relative durability or resistance to decay of untreated woods has been prepared by the Forest Products Laboratory. Service records and information collected by the laboratory form the basis of the table but it is stated not enough records exist on some of the woods to be accepted conclusively and the rating is subject to correction. The table follows:

RELATIVE DURABILITY (RESISTANCE TO DECAY) OF UNTREATED WOODS

Durability of commercial white oak taken as 100 per cent

Conifers

Cedar, eastern red (juniper)	150-200	Pine, pitch, sugar	45-55
Cedar, southern white	80-100	Pine, shortleaf	60-80
Cedar, other species	125-175	Pine, So. yellow (dense)	80-100
Cypress, bald	125-175	Pine, western white	65-80
Douglas fir (dense)	75-100	Pine, white	70-90
Douglas fir, (ave. mill run)	75-85	Pine, western yellow, pond, loblolly, lodgepole	35-50
Fir (the true firs)	25-35	Redwood	125-175
Hemlock	35-55	Spruce, Engelmann, red, Sitka, white	35-50
Larch, western	75-85	Tamarack	75-85
Pine, jack	35-45	Yew, Pacific (western)	170+
Pine, longleaf, slash (Cuban)	75-100		
Pine, Norway	45-60		

Hardwoods

Ash	40-55	Gum, red	65-75
Aspen	25-35	Hickory	40-55
Basswood	30-40	Locust, black	150-250
Beech	40-50	Locust, honey	80-100
Birch	35-50	Magnolia, evergreen	40-50
Butternut	50-70	Maple	40-50
Catalpa	125-175	Mulberry, red	150-200
Chestnut	100-120	Oaks, red oak group	40-55
Cottonwood	30-40	Oaks, white oak group	100
Elder, pale	25-35	Oak, chestnut	70-90
Elm, cork (rock), slippery	65-75	Osage orange	200-300
Elm, white	50-70	Poplar, yellow	40-55
Gum, black, cotton (tupelo)	30-50	Sycamore	35-45
		Walnut, black	100-120
		Willow	30-40

Cleveland's Westerly and Easterly Sewage-Works in Use

Design Based on Dry-Weather Flows of 32 and 92 M.G.D.—Bar Screens, Grit Chambers, Imhoff Tanks and Disinfection in Bathing Season—Multiple Lake Outlets

By George B. Gascoigne
Consulting Sanitary Engineer, Cleveland, Ohio

During the past ten years the City of Cleveland has spent about $2,500,000 in experimentation, design and construction of sewage-works looking forward to the time when objectionable conditions about sewer outlets should be abated and corrected and the bathing beach waters safeguarded. The general plan adopted is to collect the sewage from the entire city at three separate outlets, each outlet serving a district and the point of concentration serving as a sewage-works site. The three districts are the Easterly, comprising about 50 per cent of the population; the Westerly, 30 per cent;

VIEW OF WESTERLY SEWAGE-WORKS, CLEVELAND
IMHOFF TANKS AND VARIOUS BUILDINGS

and the Southerly, 20 per cent. A low-level district of small population will have to be provided for otherwise. During the past two months two plants have been placed in operation, one located on the lake front at the Easterly outlet, which affords but partial treatment, and the other on the lake front at the Westerly outlet, which is complete in every detail. The plant at the Southerly outlet has not yet been put under construction nor funds for it provided. A bond issue to complete this portion of the project will be submitted to the people in November.

Westerly Works—The Westerly sewage-works comprise large hydraulickally-operated sluice gates to control the sewage flow as it enters the plant; bar gratings to remove the coarser substances in suspension and to permit the successful operation of the tank structures; grit chambers to remove sand or inorganic matter; Imhoff tanks to remove the suspended matters which are capable of settling; disinfection equipment operated during the bathing season to destroy disease-producing organisms which remain in the tank-treated sewage; and a multiple submerged outlet to disperse the treated sewage about 3,500 ft. off shore in 35 ft. of water where the organic substances in solution are oxidized by lake water. The settled matter or sewage sludge, after remaining in the Imhoff tanks about six months for digestion and storage, will be barged for the present in its wet condition to the United States Government dumping grounds off the end of East 105th St., where it will be dumped as the dredgings from the Cuyahoga River have been for several years.

Two large interceptors for carrying combined sewage, with storm overflows of the overfall-weir type, cross the westerly part of Cleveland and discharge the sewage at the Westerly works. Generally speaking, the sewage is fresh, although devoid of oxygen at certain seasons of the year, and contains at times large quantities of industrial wastes, principally pickling liquors. Such wastes are present at times in such quantities as materially to affect the degree of purification the plant will accomplish.

The design of the westerly works is based upon an etsimated population of 288,000 persons. The population tributary to the plant when it was placed in operation July 1 is estimated at not over 200,000 persons. The average dry-weather flow for which the plant is designed is 36 m.g.d., while the maximum wet-weather flow receiving some treatment is 159 m.g.d. All devices of the works will treat at least 2½ times the normal dry-weather flow.

Easterly Works—The Easterly works are identical, generally speaking, with the Westerly works except that they are on a larger scale and that the settling tanks have for the present been omitted. It has been necessary to provide a pumping station with a maximum capacity of about 20 m.g.d. here, while the grit chambers have been entirely covered over by a brick building.

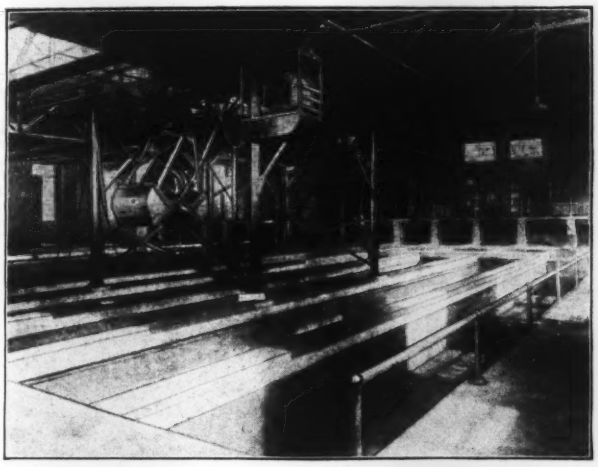
The Easterly plant will treat sewage which is entirely devoid of oxygen at certain seasons of the year. While the sewage contains large quantities of industrial wastes these wastes are so diluted by the domestic sewage that their presence is not patricularly noticeable. The design of the works is based upon an estimated population of 580,000 persons and the average dry-weather flow is estimated at 92 m.g.d. The maximum wet-weather flow reaching the works is approximately 1,000 m.g.d. daily.

Special Features of Works—Some of the special features of these works which may be of interest are outlined below. Sluice gates hydraulickally operated by pressure obtained by means of a booster pump control the sewage flow into the various grit chambers and channels. The grit chambers have pockets for collecting the grit in order that its removal may be facilitated by means of an electrically-operated clam-shell hoist which travels on a monorail. The 16 Imhoff tanks, which are built on natural foundations without piles, occupy a total area of about an acre, the entire tank structure being built in eight independent units so that should trouble develop in any of the units a large percentage of the plant can be kept in operation during repairs. Between the tanks there are constructed two galleries for removing sludge, operating the perforated water lines around the hoppers and emptying the tanks, should this be found necessary, through special drains in the bottom. Skimming chambers are provided at the entrance to each flow compartment of the tanks. The

gas vents are closed with hinged wooden covers. Owing to the lack of isolation the tanks are constructed in such a manner that they can be housed over should subsequent conditions make it necessary.

The sewage flow through the plant is measured by a Venturi meter having the necessary recording equipment. During the bathing season the effluent from the Imhoff tanks just after passing the meter is treated with liquid chlorine. The chlorine is applied by machines, recently developed, in which measured quantities of chlorine are dissolved in water in an ejector. The water solution of chlorine then flows by gravity to a grid where it is applied to the sewage through perforations. Upon the disposal areas there are substantial brick buildings of the type of architecture which is necessary to make the buildings blend with the surrounding park grounds and boulevards.

Construction—The construction of the work has included about all of the difficulties which can be encountered upon work of this kind when carried on during war times. For this reason the construction work has been long drawn out but in spite of these difficulties it is believed that substantial structures have been provided. The contractor for the westerly works was the Masters & Mullen Co. of Cleveland, while the American Construction Co., of the same city, built the easterly works. Of special interest in connection with the westerly plant is the fact that the flow partition walls were built by the cement gun.



EASTERLY SEWAGE-WORKS, CLEVELAND, OHIO
Showing covered grit chambers, sluice gates and grit removal equipment.

Operation—The operation of the sewage-works is financed by the Water Division of the Public Utilities Department. This circumstance is as it should be and it will permit operating the plants in a scientific and practical manner. A. B. Roberts is director of public utilities and A. V. Ruggles commissioner of water.

The results accomplished to date at the Easterly works in the removal of coarse suspended matter by bar gratings has been better than expected. In fact, the effect upon the bathing beach waters has been readily noticeable by those who have occasion to use the beaches. The grit chambers have been found to function efficiently and the method of removing grit is being applied satisfactorily. Although operating data are meager, they are sufficient to substantiate the conclusion stated above. At the westerly plant the effluent from the Imhoff tanks is satisfactory.

The construction of the plants has been under the general supervision of Robert Hoffmann, commissioner and chief engineer, with the writer in actual charge. A. B. Burger was resident engineer on the easterly works and J. M. Heffelfinger on the westerly works. The operation of both plants is under the immediate supervision of F. W. Jones, who formerly operated the Fitchburg works, with the writer as consulting engineer.

Financing the Works—The main sewerage improvements for the City of Cleveland have been in accordance with formal orders of the State Board of Health. The board required eliminating the foul and objectionable conditions in the Cuyahoga River and the lake front waters which are due to sewage pollution. Originally improvements to abate these nuisances were to be in operation by July, 1915, and February, 1918, respectively. On account of the experimental work and the war it was necessary to have the time for the completion of the works extended.

By proceeding in accordance with formal orders of the State Department of Health it was possible to finance the improvements outside of the normal bond and tax limitations of the city. Furthermore, only a majority vote is required for approval of such bond issues.

Tar Heater Ignites Wood Floor Through Sand

In investigating the cause of a fire which occurred on the roof of the U. S. Treasury building in Washington on May 3, while re-roofing work was going on, the Bureau of Standards made some experiments which show that heat transmitted downward from the kerosene burner of a tar heater is likely to set fire to woodwork below unless at least 6 in. of insulating sand cushion is used. Even with a 6-in. insulation the rise of temperature in a wooden floor under the sand cushion was dangerously high. The tests were made with thickness of sand cushion ranging from 2½ to 6 in. in thickness, laid on a double layer of metal sheets on a double board floor 1¾ in. in total thickness, resting on 2x10 joists; in each case the sand was covered with roofing slate ⅜ to ½ in. thick, laid close, and the bottom of the burner was 2¾ in. above the slate. In preliminary test runs with this apparatus, the woodwork of the floor charred somewhat, and as this condition would naturally occur in practice, and as the charring would increase the danger of ignition, some powdered charcoal was placed on the floor boards in the later tests. With this arrangement, in the case of 2½-in. sand cushion, fire was noticed in the floor within less than 5½ hr. after the burner was started up; in the case of 3½-in. sand cushion within less than 7 hr. (but smoke was seen coming from cracks in the floor nearly 2 hr. earlier); and in the case of 4½-in. sand cushion within less than 9 hr. With 6-in. sand cushion a run of two days was made, the first day's run being about 10 hr. and the second day's run about 12 hr., and temperatures ranging from 175 to over 200 deg. C. were reached on the wood, with much charring, but no fire started. In all the tests the layer of slate increased the protection markedly; a special run made without the slate layer resulted in earlier ignition of the wood, though under conditions not strictly comparable with the corresponding tests with slate.

Alternate Lime and Iron with Alum to Reduce Sand Size

CHEMICAL treatment of the Toledo water supply with lime and iron during the last two months in 1920 and first two in 1921 increased the incrustant deposits on the sand grains by 39 per cent and greatly lowered the efficiency. In the last annual report of R. W. Furman, chemist in charge, to George N. Schoonmaker, assistant commissioner, it is stated that subsequent alum treatment removed a portion of this coating and rendered the remaining incrustation semi-porous. Upon again changing to an iron-lime treatment in May a cementing action was started which was not thoroughly broken by washing the filters, and, aided by the porosity of the sand incrustations, entrained sufficient organic material to become heavy and later start the formation of mud balls in two of the filters. There was no surface indication of this disturbance which caused considerable trouble in July. Large quantities of Bryozoa were deposited on the sides and wash troughs necessitating daily cleaning and scrubbing to effect a removal. These troubles were overcome by a change in the wash methods and were assisted by the use of an alum treatment which was continued until the incrustation was partially removed.

The hardness of the water was comparatively uniform throughout the year although some increase was noted in the filtered water while using an alum treatment which was due to the removal of the filter incrustants.

Notes from the Intermountain Country

By W. W. DeBerard
Western Editor, *Engineering News-Record*

Denver and Pueblo

FOUR matters of public interest are vital to engineers in Colorado at the present time: Highways, waterworks, flood control and the Moffat tunnel.

Highways—More than a million people visited the national forests in Colorado in 1921 and more than a quarter of a million visited the Rocky Mountain National Park which is just outside the confines of Denver. The tourist crop, therefore, is an extremely large and important asset to the state. Under modern traffic conditions, highways are a decided essential toward keeping this tourist crop in a flourishing condition. For the last year or so the state highway department has been following a consistent policy of developing the system as a whole rather than piecemeal. This policy has been made possible by reason of the fact that the administration of the department was vested in a single individual rather than in several appointees from different parts of the state with a constituency to please, as was the former case. It is generally considered that the state is now getting more nearly than ever before value received for the money expended. The engineers have not been behind other public-spirited organizations in following the work of the highway department, and in consequence when the chief engineer, Major L. D. Blauvelt, was called to the chief engineership of the

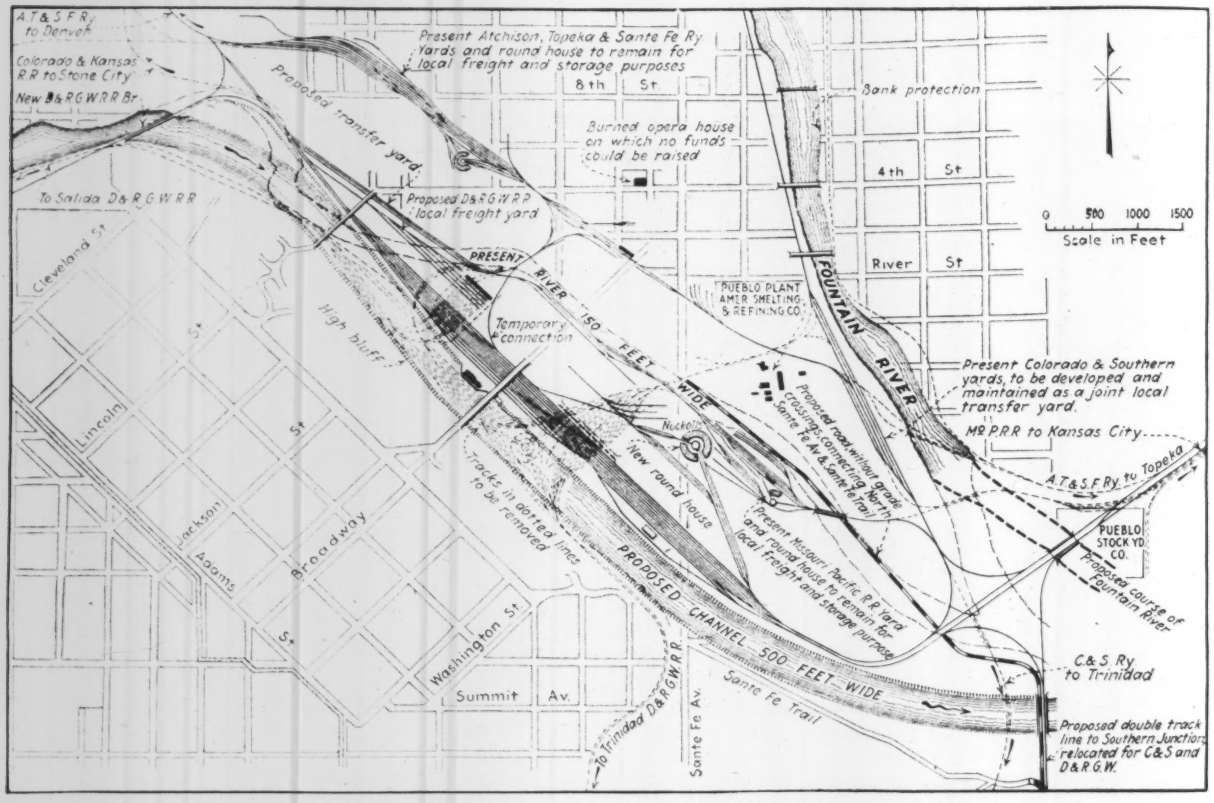

A.T.&S.F.R. to Denver
Colorado & Kansas R.R. to Stone City
New D.&R.G.W.R.R. Br.
To Salida D.&R.G.W.R.R.
Present Atchison, Topeka & Santa Fe Ry. Yards and round house to remain for local freight and storage purposes
Proposed transfer yard
Proposed D.&R.G.W.R.R. local freight yard
Burned opera house on which no funds could be raised
Bank protection
8th St
4th St
River St
0 500 1000 1500
Scale in Feet
Cleveland St
PRESENT RIVER 150 FEET WIDE
Temporary connection
High bluff
PUEBLO PLANT AMER. SMELTING & REFINING CO.
FOUNTAIN RIVER
Present Colorado & Southern yards, to be developed and maintained as a joint local transfer yard.
Proposed road without grade crossings connecting North and South Santa Fe Ave. & Santa Fe Trail
Nuckells
New round house
Present Missouri Pacific R.R. Yard and round house to remain for local freight and storage purpose
M.P.R.R. to Kansas City
A.T.&S.F.Ry. to Topeka
PUEBLO STOCK YD. CO.
Proposed course of Fountain River
Lincoln St
Jackson St
Adams St
Broadway
Tracks in dotted lines to be removed
PROPOSED CHANNEL 500 FEET WIDE
Washington St
Summit Av.
Santa Fe Trail
To Trinidad D.&R.G.W.R.R.
Santa Fe Av.
C.&S. Ry. to Trinidad
Proposed double track line to Southern Junction relocated for C.&S. and D.&R.G.W.

FIG. 1—PROPOSED FLOOD PROTECTION IN PUEBLO BY RELOCATED CHANNEL

Moffat Tunnel Commission, the engineers immediately expressed their opinion to the governor as to the choice of his successor. In Colorado there is a continuous fight between Denver and the rest of the state every time an office is to be filled by appointment. Whether it is political or not there is likely to be an alignment of these two interests. The engineers are alive to this situation and, in the interest of good engineering service and the best welfare of the state as a whole, must keep it constantly in mind.

While road contracts are being let continually and about $11,000,000 is available for construction and maintenance, one of the surprising things that one finds is the lack of all-weather pavements from Denver to the Mountains. Not much hard-road paving is being done in Colorado, but nevertheless trucks and heavy bus transportation similar to that on the Pacific Coast are coming in fast. Buses carrying 18 to 20 passengers now run on schedule between Denver, Pueblo, Canyon City and the Royal Gorge. These buses have a 68-in. tread instead of the usual 56-in. tread and surely require the construction of hard pavements for the country roads if the latter are to hold up under the traffic.

It is likely that the highway department employs as many engineers as are employed by all of the railroads coming into the state, so that the engineering profession is decidedly interested in the highway situation.

Water Problem—For the last quarter of a century the water-works of the city of Denver has been a political football. Buying out the company and putting the plant in the hands of a commission appointed by the mayor apparently has not taken it out of politics. It is not intended to imply that those who are in charge are playing politics now, although they are accused of doing so by Denver's leading newspaper and many citizens. But it is quite certain that the newspapers and many outside are playing politics. Through all the 26 years with which I have been conversant with the Denver problems there has never been a time when the engineer in charge was not loyally and faithfully doing the best he knew how to render service, and most of the time service was rendered. From the sanitary standpoint few cities have a water as carefully guarded. The supply has been under laboratory control for more than a quarter of a century. It is true pressure was not always available in high areas during the summer peak load, but it is also true that the engineer has never had money enough to furnish the unlimited supply which an unmetered system at peak load always demands. The situation this past summer has been acute, with the consumption at times 10,000,000 gal. more than the available capacity of the pipe lines from the mountain supplies to the city reservoirs. Reliance on the low night-time flow and an occasional thundershower period to replace the depleted city storage is precarious. For the last five years a water famine has faced Denver nearly every summer. It seems that it actually must be experienced before finances are provided to avoid it.

All summer long the reports of the commission of experts has been looked for. A plan behind which enough interest can be rallied to put through a bond issue to provide funds for immediate extension is the aim. It will be recalled that a year ago at a bond election the proposition to issue $5,000,000 was defeated. The commission was appointed at the suggestion of the Denver Civic and Commercial Association with the idea of creating confidence in the mind of the voter. Judging from newspaper accounts anything but this result has been accomplished so far. It remains to be seen whether the report of this commission of outside experts is going to be respected and backed or discredited as too many consulting engineers recently have found their reports treated in western cities. How engineering societies are to treat expert reports is a

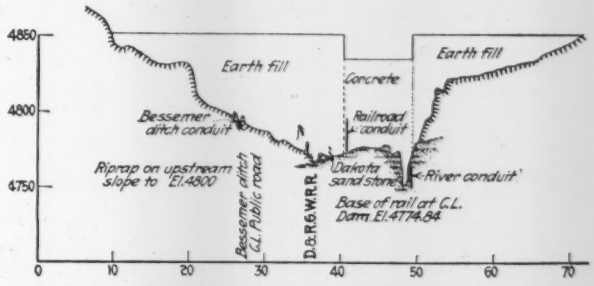


FIG. 2—PROFILE OF PROPOSED ROCK CANYON RETENTION DAM

problem easy to talk about in the abstract but decidedly troublesome in practice. If engineers refuse to accept the findings of their fellows how is the public expected to place much credence in the profession as a whole. The attempt to throw the question of technical decisions into the hands of the common voter should certainly not be the aim of any member of the professeion. This subject may not be a question of ethics but it is near to it. All over the country the same problem arises continually. Engineering societies might with profit discuss the question of handling expert reports from the ethical standpoint.

Pueblo also has a water problem of no small dimensions. It has a North Side commission and a South Side commission, each with a full set of officers and operators. For one of the plants a 4-mile stretch of 24-in. conduit has about reached the end of its useful life. Funds for replacement will be hard to raise and the question of uniting the two systems will undoubtedly complicate the matter, as will the choice of material. Just how far the engineering profession in Pueblo will interest itself in this semi-political and professional problem remains to be seen.

Flood Control—The floods at the end of July in Denver, which carried away several bridges, may activate and bring home anew to the citizens of the state the value of the recent conservancy act, enacted mainly for the benefit of Pueblo. Until the floods of last June Pueblo was a hide-bound town controlled largely by a few large interests. Much public consciousness has been awakened by the late disasters, when 120 lives were lost and 140 individuals were reported missing or unaccounted for, together with a property loss of $20,000,000, due to an estimated peak discharge of nearly 100,000 sec.-ft. D. P. Gaymon, city engineer, states that the city has been very materially waked up. Paving, sewers, waterworks and flood prevention, together with improvements of bridges and viaducts are all being considered seriously. Nearly a million yards of paving by special assessment is being put down. Storm sewer designs are on the boards but must await final decision as to the type of flood protection provided.

As to the flood situation, the county and city commissions have been working in harmony with the com-

mercial organizations and undoubtedly a decision on a choice of one of the three plans which have been worked out by the Dayton-Morgan Engineering Co. under Burton Jones, the resident engineer, will be wisely made. Of the few engineers interviewed there did not seem to be much difference of opinion as to the superiority of one of the plans. The first plan contemplates a storage detention reservoir; the second, an enlargement of the present channel in its present location; the third, moving the present channel to the south bluff of the flood plain and re-locating practically all of the railroad yards, many of which now run transversely across the flood plain. The last plan, shown in the map herewith, is considered the best because it will give the town and the railroads more for the money than either of the other two. This new channel near the south bluff would care for 250,000 sec.-ft. The old channel was constructed for 40,000 sec.-ft. while the flood was approximately 100,000 sec.-ft. Investigations of the engineers indicated that only a comparatively short transfer of the storm center to the west last June would have increased the crest discharge enormously. Plan 3 will require the removal of the present railroad tracks to the opposite side of the Union station and will eliminate the short and inconvenient transverse yards to the north and the south of the station. In their place will be a set of long tracks running parallel with the river and flood plain. Much economy of time and operating expense will be obtained by straightening out the tangle of railroad tracks.

A site for a dam to retain sufficient water so that only 35,000 sec.-ft. may pass has been found. The dam can be located on bed rock now exposed (Fig. 2). It will provide safety, but it has no civic betterment features or any but extremely infrequent usefulness. The railroads will probably be in favor of the dam project unless they can be successfully sold by engineers on the ultimate economy of the project to relocate the channel.

Engineers over the country may have the idea that Pueblo has been laying down on the job. This is decidedly not the case. The solution of the problem has been worked out fairly well in detail. Progress is being made as fast as the legal red tape with reference to the conservancy district plan can be unwound. However, the necessity for speed is nowhere more evident than in Pueblo as may be illustrated by the following incident: Recently a large opera house in the affected district burned to the ground. It is stated that financial interests will not furnish sufficient money to the owners to permit them to clean up the debris, even from the sidewalks, until the flood protection is assured.

Further activities which have been carried on since the Dayton-Morgan Engineering Co. took over the work are evidenced in the reconstruction of the broken levee above town and the building of a line of retards along Fountain River to protect valuable residence districts from a caving bank, and in the strengthening of bridge foundations which were found in a precarious condition. In the construction of the retards old rails were driven 10 ft. apart into shale and covered with No. 9 fence wire. Brush was piled loosely back of this fence. Already a material deposit of silt has been made by a single small flood. It was my observation that the Pueblo situation is in the hands of a united commercial and official city in accord with the engineers. Although the latter have no small problem ahead of them in educating the public to the plan best not only from an engineering but a civic standpoint, they will succeed.

Moffat Tunnel—For more than a century engineers have dreamed of the economy and usefulness of tunneling the range almost directly west of Denver. Ever since the construction of the Denver & Salt Lake R.R. the project has been especially attractive, for Denver would then be put on the shortest and most direct transcontinental route. The road opens up a new empire with anthracite coal fields rivaling those in Pennsylvania, abundant gilsonite, oil shales, timber and mined products. The distance by rail to Grand Junction will be reduced by one half, to 173 miles. The 6-mile tunnel will cut out 23 miles over the Divide as well as the snow sheds and a 4 per cent grade. Engineers estimate that about 40 per cent of the annual profits of the road now are absorbed by snow conditions encountered in crossing the Divide at the 11,660-ft. elevation. The tunnel is to be 16 ft. wide and 24 ft. high. A pioneer tunnel 8 x 10 ft. will be driven 50 ft. to one side of the main tunnel. It is proposed to use the pioneer tunnel to carry power, light and compressed air to ventilate the main bore. Another use is to carry water from the western slope to South Boulder Creek. While at the present time land hunger is not particularly in evidence in the West, it will come again and there is plenty of justification in looking ahead to make accessible all available parts of the country for the development of agriculture. The northeastern part of Colorado and the northwestern part of Utah embrace an immense tract of agricultural land.

Engineers should be gratified that the Moffat Tunnel construction has fallen into the hands of so able an engineer as Major Blauvelt, who put through the Moffat road and knows the history and engineering of the preliminary work of the tunnel from the beginning. At the head of the commission is W. C. Robinson, former president of the Denver Union Water Co., than whom there are few abler men working with engineers to get work done in a smooth and efficient manner. He knows how to handle finances under difficulties and keep things going. It is hoped to let contracts this fall and complete the tunnel in three years. While the work is being carried out under a rather novel law, that of the special benefit district, a friendly suit is now in court to determine its status. If this is decided favorably, undoubtedly other projects of similar character may be put through in the West on the same basis. From now on visits by engineers to Colorado will not be complete unless they get in touch with Colonel Blauvelt and follow the work of this latest railroad development.

No mention of the tunnel would be fitting without a tribute to D. H. Moffat, who at the age of 65, built the road and really died of disappointment 11 years ago because he was not successful in financing the tunnel. Few men have done more for Colorado than did Mr. Moffat. At the age of 30 years he fathered the construction of what is now the Union Pacific from Denver to Cheyenne. He built the "South Park," now part of the Colorado & Southern, and the Florence & Cripple Creek, both heavy dividend payers in their time. As president of the Denver & Rio Grande he constructed the Creede Branch. He poured $20,000,000 into the construction of the Denver & Salt Lake because he firmly believed that it would make Denver one of the leading western cities. Will it?

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Cast-Iron Pipe to Be Used for First Time in Water-Works of Ogden, Utah

Sir—The city of Ogden, Utah, with nothing but steel pipe in its water-works distribution system heretofore, has recently taken a significant step in awarding a contract for some 2½ miles of cast-iron pipe to the F. W. Spencer Co., Salt Lake City, after duly considering much lower bids for steel pipe.

The Ogden water-works were built by a private company which installed steel pipe with the idea that the plant would be eventually sold to the city and that it could probably get as much for the system if steel pipe were used as it could for cast iron. After the city took over the system it continued to use steel pipe. Not long ago there was a change in administration at Ogden and the new city engineer felt that to put steel pipe under pavement in a city having a population of 35,000 was false economy. Accordingly, the first cast-iron pipe ever laid in Ogden is being put down this season.

The entire intermountain country is gradually standardizing on cast-iron pipe. Many other types of pipe have been used in this territory. In fact, it is impossible for many of our smaller communities to legally bond themselves for enough money to put in cast-iron pipe for a water-works system. There is considerable difference in price on account of high freight rates between cast-iron and steel. C. E. PAINTER.

Salt Lake City, Utah.

[The work consisted chiefly of furnishing and laying 13,270 ft. of cast-iron pipe made up of 1,520 ft. of 6-, 9,300 ft. of 12-, 2,350 ft. of 14- and 100 ft. of 8-in. In addition there were a few valves, hydrants, etc., to be supplied and set and some miscellaneous work to be done. The entire contract was let for $49,202. The successful bidder offered to do the same job for $40,263 if "M. J. galvanized and dipped [steel] pipe" were used or for $36,960 using the same material, dipped only.

A better comparison of the relative costs of the cast-iron and steel pipe is afforded by giving the unit bids for the 9,300 ft. of 12-in. pipe which makes up the bulk of the job. For this the city will pay, under the award, $3 per lin.ft., and could have had steel from the same bidder at $2.35 for galvanized and dipped and $2.09 for dipped only. The lowest bids for the three classes of pipe were $2.98, $2.30 and $2.05 respectfully. Further details of the bids are given in our Business News section.—EDITOR.]

Strength of Old Brickwork Due to Hardening of Mortar

Sir—With reference to article on "Brickwork from Building Stronger than Laboratory Samples," appearing on p. 354 of your issue of Aug. 3. The writer of the article in question evidently forgets that the brickwork in question was nearly twenty years old, and that portland cement mortar goes on hardening for many years. Laboratory specimens are rarely tested beyond a few months. If the workmanship in the two cases were equal, the brickwork from the building would be much more than 4 per cent stronger than laboratory specimens. In fact from the data given I would be inclined to draw the conclusion that laboratory specimens have better workmanship than is found in actual buildings, the opposite of the author's conclusion. LEO G. HALL.

Downers Grove, Ill.
Sept. 19.

No. 19 Gage Too Light

Sir—We wish to call your attention to a slight typographical error which occurred on page 322 of your issue of Aug. 24 in the article by P. F. Jones entitled "Corrugated Culvert Pipe Jacked through Embankment."

The gage of the 30-in. Armco corrugated pipe employed is stated as 19, whereas it was really 10 gage. This we know because we manufactured the pipe in question. It seems to us worth while to call attention to this because so light a gage as the one stated would be extremely inadvisable for corrugated pipe, whereas 14 gage material is usually employed and 12 or 10 gage where subject to unusual conditions. No doubt in this instance the typesetter or typist simply picked up the wrong figure.

CALIFORNIA CORRUGATED CULVERT CO.

West Berkeley, Calif.
Sept. 12.

Bridge Builders And Highway Bridges

Sir—On the basis of extended experience in the bridge building industry it seems to me that old-time bridge builders were unduly criticized and modern bridge departments of state highway commissions unduly lauded in the article on the failure of the Marlin Bridge (see *Engineering News-Record*, June 22, 1922, p. 1023).

A complaint that highway commissions build too many structures of an expensive type has been answered by stating that the commissions merely execute the orders of legislative authorities and what is supposed to be the popular will. But there is no authority, legislative or otherwise, which dictates what class of bridge shall be built, except occasionally a local community. On the other hand, nobody calls a commission to account for excessive expenditures, as would be done in the case of local authorities.

In a specific case, local authorities built ten years ago an earth-filled concrete arch bridge at a cost of about $7,000. Near this and over the same stream the state is building a concrete arch rib bridge at a contract price nearly four times as great, although the site is more favorable for the other and less expensive type. Increased prices are not responsible for this great increase in cost. If such a contract had been let by the local county commissioners the taxpayers would soon have put them out of office. But when the state does it, the local officials have no responsibility and the local community is given to understand that the bridge is paid for mainly out of state funds so that the community pays only a small proportion of the cost. Many bridges of crude and extravagant design are being built at a cost 50 per cent greater than that for which well-designed structures might be built, following the same dimensions and specifications. Furthermore, in the central states it is the custom to build concrete through girder or truss bridges with roadways so narrow that in a few years they will have to be widened, which can be done only by building entirely new structures. Steel bridges are now only a small part of the business, but in these also it is believed a good designer could make a large saving in material and workmanship.

One reason for these conditions is that few competent and experienced engineers are to be had for the salaries paid by the state highway commissions. As a result, few of the best men stay in these positions. Many of the engineers have had no previous outside or commercial experience in highway bridge design or construction. To the layman all engineers look alike. He assumes that the engineer will see that only a fair price is paid and no money is wasted. He cannot check up the excessively expensive design of the structure as he could if there were competitive designs.

How can the public benefit from the knowledge of economical design and construction of competent and experienced designing engineers if these engineers are not permitted to demonstrate what can be done with a given situation? To my mind competitive designs certainly appear an improvement on present methods. It is true that local

authorities are not competent to pass on bridge designs and that they judge a competition mainly on the matter of price. Thus sharp competition and limited funds available for construction led to many light structures in earlier days. But with the highway commission and its engineer passing upon the designs the case would be very different.

Consider the plan of having competitive designs submitted with the contractors' proposal at the time of taking bids on the work, it being understood that all designs must meet the approval of the commission's engineer. If the plan of the lowest bidder does not meet the requirements it is rejected and the next one considered, until a plan and bid are found that do meet the requirements. This plan also would provide employment for many engineers in making designs for contractors, and since the plans would be subject to expert consideration these engineers would of necessity consider both quality and cost of the design. The cost of making the designs would be small in comparison with the saving of cost in an economical structure. Under the present monopolistic system there is little regard for economy in design and no incentive to improvement in design.

Many contractors who are now building country bridges have little experience, equipment or resources. Some of them do not last more than one season. Compare this situation with the old bridge building companies of 25 years ago, having their own engineers, full equipment, ripe experience and ample means. Much has been said about failures of old highway bridges, but as the late Horace E. Horton stated some years ago: "No one has shown or can show the actual failures of enough highway bridges within a given period of five, ten or fifteen years, to justify suspicion of the highway bridge as a class." And failures are on record of bridges built under the jurisdiction of state highway commissions, although these structures are comparatively modern.

It is a point to be decided by the engineers themselves, in their own interest as well as in that of the public, whether the proper and economic method is to have highway bridges designed by state engineers without competition or by outside competent engineers in competition but subject to specified requirements and to expert approval. But in my opinion the bridge engineer of a state highway commission should act as a supervisor of design and not as a designer.

A BRIDGE BUILDER.

Calculation of Bridge Waterways in Brazil

Sir—It was with the utmost pleasure and interest that I read Ivan E. Houk's article on the "Hydraulic Design of Bridge Waterways" in your June 29 issue, p. 1071. My experience with runoff formulas fully bears out what Mr. Houk says. For some years I have been studying the problem of rational waterway design, and I also advocate the "Rational Method," as used in sewerage practice. My method of procedure may prove interesting to some.

I compute the mean intensity of rainfall by a formula I have evolved,

$$i = \frac{4.75f}{\sqrt[6]{(t+5)^5}} = \frac{4.75f}{\sqrt{t+5}\,\sqrt[3]{t+5}} \qquad (1)$$

in which

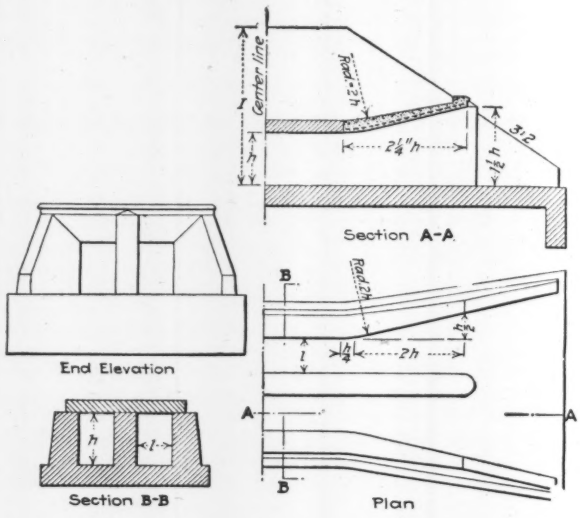
i = intensity of rainfall, in. per hr.;
f = mean annual rainfall on drainage area, in.;
t = duration of storm, min.

The formula represents maximum storms, and I usually calculate culverts and small openings in general for an intensity two-thirds as great. Whenever the data at hand are not very complete, and this unfortunately is often the case, I assume 85 per cent of the rainfall as runoff.

For large areas, values given by eq. (1) have to be properly reduced, as it is a well known fact that mean intensity of rainfall decreases with increasing area of storm. Denoting the drainage area in square miles by A, the formula is modified thus:

$$i = \frac{4.75f}{\sqrt[6]{(t+5)^5}} \times \frac{1}{1+\frac{1}{8}\sqrt{\frac{A}{1000}}} \qquad (2)$$

Of course this formula is more or less of a tentative nature, and does not presume to hold true for every case that may arise. However, small variations in the correction factor for A are unimportant in the great majority of cases.



FUNNEL-SHAPED CULVERT ENTRANCE

For a first trial I proportion the area of waterway by one of the following formulas:

$$a = 2.86Cf\sqrt[6]{A^5} = 2.86Cf\sqrt{A}\,\sqrt[3]{A} \qquad (3)$$

$$a = 5.71Cf\sqrt{A} \qquad (4)$$

where a = area of waterway, square feet;
A = drainage area, square miles;
f = mean annual rainfall, in., on area A.
C = a coefficient as tabulated below.

VALUES OF COEFFICIENT C, FORMULAS (3) AND (4)

Nature of Ground	C
Very steep barren and rocky ground; upper reaches of stream have a much greater slope than lower ones	1.10 to 1.50
Steep, impermeable ground, little or no vegetation	0.90 to 1.00
Mountainous ground, cultivated or pasture	0.70 to 0.80
Swamps with no vegetation	
Hilly ground, cultivated or pasture	0.50 to 0.60
Swamps with vegetation	
Undulating ground, pasture or cultivated	0.30 to 0.40
Flat land, pasture or cultivated	
Long narrow valleys	0.25 to 0.20 or even less
Sandy deserts	0.01 and less

Formulas (3) and (4) were deduced by me from Dun's Drainage Table. The values of C are only approximate and of a tentative nature. I use formula (3) for drainage areas not exceeding 8 square miles, and where the culvert can be made to discharge under a head.

As a matter of fact I try, whenever possible, to make box culverts and such like openings discharge under a head, as large economies can usually be effected in this manner. In order to increase the efficiency of these openings I employ a funnel-shaped inlet as per drawing, to decrease the loss due to entrance head. The outlet is of the ordinary standard type.

Once the trial sectional area of waterway is worked out, it is an easy matter to see if it can take care of the given flood and yet be safe as to scour, etc.

It would be highly instructive and interesting if railway and highway engineers and others could give their views on and cite their experiences and methods for dealing with the problem in hand.

GEORGE RIBEIRO,
Chief of Permanent Way Drawing Office,
Leopoldina Ry. Co., Ltd.

Rio de Janeiro, Brazil,
July 30.

NEWS OF THE WEEK

New York, September 28, 1922

New Muscle Shoals Bill Is Introduced

Would Give Secretary of War Authority to Dispose of Units on Best Terms Possible

A new measure for the disposition of the government properties at Muscle Shoals, Ala., which in effect would pass the entire subject back to the Secretary of War, with authority to dispose of the various units on the best terms possible, appeared in the final days of the session of Congress in the form of a resolution introduced by Representative H. E. Hull, of Iowa, a member of the Military Affairs Committee.

The resolution would authorize the Secretary to sell to the Alabama Power Co. the government's interest in the Gorgas steam plant and the transmission line to Sheffield at a price not less than $3,000,000, or if unable to negotiate a sale, the secretary would be authorized to purchase the sites and rights of way from the Alabama Power Co. at a fair price within his discretion or to secure the property by condemnation proceedings if necessary.

Purchase of all property and flowage rights abutting the site of proposed Dam No. 3 and which belong to the Alabama Power Co. at a price not to exceed $100,000 would be authorized, condemnation proceedings to be instituted if agreement could not be reached.

Lease for Two Dams

The Secretary would be authorized to complete at government expense Dam No. 2 and to construct Dam No. 3 and to lease these dams together with the power houses and appurtenances for not to exceed fifty years at a rental of not less than 4 per cent of the cost of finishing Dam No. 2 and constructing Dam No. 3, including in the latter case cost of site and flowage rights.

As to the nitrate plants, the resolution provides that the Secretary in his discretion may lease for not exceeding fifty years Nitrate Plants Nos. 1 and 2 and Waco quarry, either separately or completely, at $1 per year for each plant. The condition of such lease would be that the nitrate plant or plants should be operated at capacity for the production of fertilizer components for sale to the public at a price not to exceed eight per cent profit and that the plants be kept in condition to produce to present capacity nitrates and other components of munitions, the plants to revert to the government in case of emergency.

The Secretary would be authorized to lease the dams and nitrate plants and quarry separately or completely to the same lessee and to make the consideration interdependent.

Authority to sell or dispose of all lands and properties owned by the government not necessary for the operation of the nitrate plants, the steam electric plants or for the construction and operation of the dams will be given the Secretary.

In explaining his resolution, Representative Hull said that its terms would permit Henry Ford, the Alabama Power Co., or any other reliable person or organization to make the contract, and that the resolution would afford the Detroit manufacturer or anyone else a better opportunity to operate the nitrate plants for the benefit of the people of the country than Mr. Ford's own offer.

Fire Destroys Wood and Steel Wharfhouse at New Orleans

On Sept. 15 fire completely destroyed the wharf and wharfhouse of the port terminal built at New Orleans by the government for the war and known then as the New Orleans Army Base. At the present time the terminal is under lease to the local Dock Board and is being used for commercial purposes. Damage to the structure amounts to about $3,000,000 and to the contents of warehouse and cars as much again.

The terminal was described in *Engineering News-Record*, April 24, 1919, p. 823. The part destroyed was a wharf, or quay, paralleling the river and on the river side of the levee. It was 2,000 ft. long and 170 ft. high and was built of wood piles carrying a timber floor. On it was a steel frame warehouse 141 ft. wide. This structure was connected to large shoreward concrete warehouses by bridges but the fire was stopped across the bridges and the concrete warehouses were not damaged.

A full description of the fire and the damage done will appear in the next issue of *Engineering News-Record*.

Begin Dam Survey as First Step in Texas River Control Program

Acting on a petition of officials and citizens of Ft. Worth and Tarrant County, Texas, the State Board of Water Engineers on Sept. 1 began the survey of a reservoir and dam site on the Clear Fork of the Trinity River. The topographic work will be done by the U. S. Geological Survey in cooperation with the Board of Water Engineers. Jay M. Whitman of the U. S. Geological Survey will be chief of the topographic party and it is estimated that the survey will require 60 days for completion. This is the first definite step taken since the flood conferences to control the streams of the state.

For State Control of Texas Roads

The Democratic State Convention of Texas, held at San Antonio, Sept. 5 and 6, adopted a highway plank in its platform approving the highway program of the Texas Highway Association, which calls for a constitutional amendment to turn over the roads to the state for construction and maintenance. This work is now under the direction of the counties.

Child Killed in Collapse of Theater Floor

Rotted Wooden Joists of Lobby Floor Break Under Weight of Crowd of School Children

Collapse of part of the lobby floor of the Strand moving-picture theater, East Liberty, Pittsburgh, on Sept. 22 killed a school child and seriously injured a large number of others. The accident occurred when a crowd of children was waiting in the lobby to see a free performance. The owner of the theater, who was present, also was injured.

The facts of the accident are reported as follows by Edward Godfrey, structural engineer, who investigated the collapse for *Engineering News-Record:*

The theater lobby is about 32 ft. wide between brick side walls. It was floored with a 5-in. slab of plain concrete resting partly over and partly between transverse wooden 2 x 10 joists. These joists extended from wall to wall, entering the brick work about 2 in. At their middle points they were supported by a line of double I-beams extending from front to rear, carried on columns. Some if not all of the joists had 2 x 4's on their sides to carry the concrete. The same floor construction continued throughout the theater itself. The building was erected in 1914; it is not known at present writing whether the floor in question dated from that time or had been put in at a later reconstruction. The cellar was unoccupied and had a dirt floor; the space was not ventilated and was damp.

One-half of the lobby floor, an area about 15 or 16 ft. square, collapsed and fell a dozen feet or so into the cellar, carrying with it the crowd standing on it. The joists were sheared off at the side wall and at the middle line of beams, and were broken up in the fall. Examination showed that they were badly rotted. The damp cellar without ventilation and the impervious concrete floor made ideal conditions for decay, and this appears to have been not long in doing its work.

Commenting on the accident Mr. Godfrey says: "There is no mystery about the cause of the collapse, except the mystery of why any one engaged in building should construct such a trap and why those who are morally responsible for the lives of the public from which they draw their living should be indifferent to the existence of such traps. However, it would be interesting to know why the designer used this heavy layer of plain concrete on a floor wholly supported by wooden joists, and how much he penalized his client by not reinforcing the concrete and omitting the wood. It would also be of value to find out, if possible, what other examples of the same designer's work may be in service. It is certain that a very superficial examination of this building by an expert would have discovered the danger of permitting it to be used by the public."

Port Authorities Convene at Toronto

Discuss Proposed St. Lawrence Channel and Urge Greater Uniformity in Port Design and Equipment

Fifty members, representing the principal American and Canadian seaport cities, attended the annual convention of the American Association of Port Authorities held in Toronto, Sept. 14-16. President Benjamin Thompson of Tampa, Fla., occupied the chair. Official welcomes were extended by Mayor Maguire on behalf of the city and President D. A. Cameron of the Board of Trade. J. Spencer Smith delivered an address on the Port of New York, which had been prepared by E. H. Outerbridge, chairman of the Port of New York Authority, who was prevented by illness from attending the convention. This outlined the methods by which that city is attacking the problem of co-ordinating its rail and water transportation facilities. Chief Engineer B. F. Cresson, Jr., of the Port of New York Authority, urged the importance of adequate freight-handling equipment and advocated greater uniformity as to port facilities and channel depths.

E. St. C. Maxwell, of Baltimore, dealt with the control of waste oil in harbors. Other addresses were: "The Navigation of Industrial Canal of the Port of New Orleans," by General Manager J. H. Walsh; "The Proper Ratio of Berthing Space to the Cargo Tonnage Requirements of Ports," by Capt. S. S. Sandberg, traffic manager, Los Angeles harbor; "Rail Freight Rates and the Development of Lake Ports," by William H. Adams of the Detroit Board of Commerce; and "Destructive Action of Marine Borers," by Dr. Herman von Schrenk of St. Louis.

Discuss St. Lawrence Waterway

On Sept. 14 a banquet was tendered by the city to the delegates and the projected deepening of the St. Lawrence water route was keenly discussed by the speakers. The plan was advocated strongly by T. L. Church, M.P., of Toronto, and J. B. Strauss of Chicago, and opposed by Dr. W. L. McDougall, chairman of the Montreal Harbor Commission, and John N. Cole of Boston. On resolution of B. F. Cresson, Jr., of New York the convention moved that an effort should be made to bring about greater co-operation between those responsible for the development of ports with a view to determining economies that can be effected by greater uniformity in port design and equipment. A committee was appointed to communicate with the authorities of the principal ports throughout the world with a view to determining how far international co-operation in design and equipment can extend and the best method of bringing it about.

The election of officers resulted as follows: Michael P. Fennell, Jr., general manager of the Port of Montreal, president; J. H. Walsh, of the port of New Orleans, first vice-president; B. F. Cresson, Jr., second vice-president; E. L. Cousins, engineer, Toronto Harbor Commission, third vice-president; T. S. McChenney, of New Orleans, secretary; and J. C. Marron, of Seattle, treasurer.

The following were elected as directors: Major General Lansing H. Beach, chief of engineers, United States Army; A. G. King, director, Norfolk Harbor Commission; H. G. Hegart, chief engineer, Harbor Board of Portland, Ore.; Brig. General Thomas Tremblay, Quebec Harbor Commission; B. C. Allen, director of Port of Houston, Tex.; Charles W. Francis, commissioner of Public Works, Chicago; and Major C. T. Leed, consulting engineer, Los Angeles, Calif. Executive committee was elected as follows: John N. Cole, public works commissioner, Boston; Benjamin Thompson, consulting engineer of Tampa, Fla. Harbor Commission, the retiring president of the association, and John H. McCallum, president of the port of San Francisco.

New Orleans was chosen as the meeting place for the next year's convention.

Good Market for Highway Bonds

During the past week two large issues of state highway bonds were reported sold on favorable terms. The largest sale was an Illinois issue of $7,734,000, 1929-40, 4 per cent bonds, which sold on a 3.9 per cent basis. Michigan sold a $3,000,000, 1937-42, 4-4½ per cent issue to yield 4-3.95 per cent. A half million of 4½ per cent Alabama road and bridge issue, due in 1931, sold to yield 4¼ per cent. Five issues of county road bonds in various states were offered at interest rates and sold to yield as follows: 4¼ at a yield of 4.05 per cent; 4.75 at 4.5; 5.5 at 5.5; 6 at 5; 6 at 4.75 to 4.76.

Construction Council Executive Secretary Appointed

Pending the complete organization of the American Construction Council, the temporary operating committee is continuing to function. Committees are to be appointed to co-operate with railroads on freight-rate matters, and on finance, membership, building codes and ethics. The temporary headquarters are being continued in the Munsey Building, Washington, D. C. Col. Wm. Couper has been appointed temporary executive secretary and is now busying himself with details relative to financing the organization.

British Plan Next Rail Merger

(London Correspondence)

It is probable that the next step in the British railway grouping scheme will be the absorption of the great Central by the North Eastern Ry. The North Eastern owns 1,714 miles of track and jointly 36 miles more, and the authorized capital is £92,716,199. The Great Central was formerly known as the Manchester, Sheffield and Lincolnshire Ry., the title having been changed on the extension of the line to London for mineral traffic in 1898, and for passenger traffic in the following year. For some years now this line has operated in close relationship with the Great Northern and Great Eastern lines. The authorized capital of the Great Central is £64,043,511. When complete the group to be known as the North Eastern will include also the Great Northern and Great Eastern lines.

Report Advises Abandonment of British Columbia Railway

The Pacific Great Eastern Ry. in British Columbia, now owned by the government of that province, has become a serious financial problem because of the non-revenue producing condition of the road and the heavy interest, depreciation and operating charges which taxpayers have to meet. John G. Sullivan, consulting engineer of Winnipeg, Canada, and former chief engineer of the Canadian Pacific R.R., was retained by British Columbia to advise the province what policy to follow in further management of the Pacific Great Eastern Ry. properties.

A terse summary of the whole situation was recently printed in a Vancouver newspaper as follows: "The Pacific Great Eastern has proven a mirage of hope to hundreds of settlers in the central and northern valleys. It was the plaything of politicians, a gold mine to contractors, a bugbear to engineers and in recent years has been a millstone around the neck of the taxpayers."

Mr. Sullivan presented his report several months ago but no announcement of its contents was made public until recently when John Oliver, premier of British Columbia, gave out a digest of its main features from which the following has been taken:

Sullivan's Report

Except for a 45-mile stretch, the line has been completed from tidewater at Squamish, about 35 miles north of Vancouver, to Ft. George on the Grand Trunk Pacific R.R., 430 miles to the north. Because there is not enough traffic in prospect to pay operating expenses and fixed charges, the abandonment of the entire system is suggested as one alternative. This would make it possible to recover some salvage and would prevent further increase in obligations which the taxpayers of the province will have to meet. In any event no extensions of the present system are advised and curtailed train service and increased rates are recommended. Parts of the line on which there is snow trouble in winter should be abandoned; some of the rolling stock could be sold and gasoline driven motor cars used for passengers and freight on those portions of the line where traffic is heaviest. The possible sale of that portion of the line now operating between North Vancouver and Whytecliffe to a private company is suggested, as is also the possibility of selling other portions of the road to lumber interests.

The report is now before members of the Legislature and decision as to what to do with the railroad properties is expected at the next session of that body.

Deyo's Service on New York Subways

In the obituary notice of S. L. F. Deyo, published in *Engineering News-Record*, Sept. 14, p. 454, the statement was made erroneously that from 1908 to 1913 Mr. Deyo was chief engineer of the Rapid Transit Subway Construction Co. George H. Pegram has been chief engineer of both the Rapid Transit Subway Construction Co. and the Interborough Rapid Transit Co. from 1905 to date.

Los Angeles Aqueduct Breaks Repaired with Steel Pipe

Two interruptions to the flow of water through the Los Angeles aqueduct occurred in the latter part of August but did not curtail the city's water supply because of reservoir capacity at the lower end of the aqueduct. The first break was in the Little Lake division at the upper end of tunnel No. 1. "This district," states William Mulholland, chief engineer, Los Angeles Bureau of Water Works and Supply, in a letter to *Engineering News-Record* dated Sept. 2, "is subject to earthquake shocks and several of these which occurred just previous to the discovery of the break doubtless caused a settlement in the fill which was made of the tunnel dump. Cracks in the bottom of the invert allowed a certain amount of seepage which caused further settlement and resulted in the collapse of the slab due to the length of unsupported span. About 138 ft. of this section was taken out. Within five days after the occurrance a temporary 9-ft. steel pipe on trestles was erected and 85 per cent of the aqueduct flow was passing through this temporary repair. This is to be kept in service until permanent replacement can be made by means of a 9-ft. steel siphon.

"On the morning of Aug. 29 a cloudburst occurred in the Olancha Canyon, discharging over the aqueduct which at this point consists of a lined open canal. No damage was done to the concrete lining, but the aqueduct was completely filled with rocks and mud for a distance of one-half mile. The removal of this debris is simply a steam-shovel job which at the most will require only ten days to two weeks to complete."

Public Building Bill Planned to Carry $80,000,000

An omnibus public building bill, carrying an appropriation of $80,000,000 to $100,000,000, will be introduced and pressed for passage when Congress reconvenes. Before leaving Washington for the recess, Representative Langley, of Kentucky, chairman of the House Public Buildings and Grounds Committee, and Representative Clarke, of Florida, ranking Democratic member of that committee, conferred with President Harding and informed him that such legislation was desirable. No general public buildings bill has been passed by Congress since 1913, and there have been comparatively few special bills enacted to erect government buildings of a permanent nature.

There are pending before committees literally hundreds of bills seeking the erection of postoffice buildings and other quarters for Federal departments in cities other than Washington. The pressure for favorable reports and legislative action upon many of these bills is steadily increasing.

Postmaster General Work recently launched a campaign to convince Congress that it would be financially profitable for the United States Government to build or purchase postoffice buildings in the major cities of the country rather than continue the old system of leasing most of these quarters. The Postoffice Department hopes to have this building done according to a systematic plan rather than to leave it to the chance enactment of legislation by Congress on a piecemeal system.

South Carolina Licenses First Applicants Under New Law

Thirty-seven applications for registration as engineers or land surveyors were approved at a meeting of the South Carolina State Board of Engineering Examiners held in Columbia, S. C., this month.

The organization of this board was The organization of this board was provided for by an act passed at the last meeting of the state legislature, and the thirty-seven who received approval comprise the first "registered" professional engineers and land surveyors in South Carolina. Members of the board of examiners are G. E. Shand, Columbia; L. S. Tellier, Charleston; T. Keith Legare, Columbia; W. S. Tomlinson, Columbia, and George Wrigley, Greenville.

Twining Urges Construction of Broad St. Subway

Immediate construction of a rapid-transit subway extending along North Broad St., Philadelphia, was urged upon the city council by W. S. Twining, director of city transit, on Sept. 21. A four-track line six miles long was proposed, costing with equipment about fifty million dollars, of which about thirty-one million represents the cost of the structure. Mr. Twining strongly opposed an elevated railway as a substitute for the subway, but estimated its cost as twenty millions less.

Suspension Bridge Planned Across Carquinez Straits

A suspension bridge across a narrow strait in the upper reaches of San Francisco Bay—Carquinez Strait between San Pablo and Suisun bays—has been proposed by a company organized for the purpose, known as the San Francisco Transit Co. The structure would have a central span of 1,500 ft. and two 750-ft. approach spans and would be a high level highway bridge, giving a clearance of 135 ft. above water level. The estimated cost is given as $2,500,000.

After a hearing conducted before Colonel Herbert Deakyne, the United States Army engineer officer at San Francisco, the War Department has approved the clearances proposed. Issuance of a permit awaits the grant of local franchises and completion of arrangements for proceeding with the work.

Applications for franchises from Solano and Contra Costa counties, between which the bridge will extend, are now under consideration. The proposition made to these counties is that if the franchises are granted the operating company will, at the end of twenty-five years, turn the bridge over to the counties without charge and in a good state of repair. So far as actual construction problems are concerned, the proponents state that the work could be started within sixty days and the bridge completed and ready for service within twelve to eighteen months.

C. E. Fowler, of New York, is consulting engineer for the company and designed the proposed structure. Edwin Duryea and H. L. Haehl of San Francisco are the resident consulting engineers.

Propose Development Plan for S.P.E.E.

Committee Recommends Comprehensive Plan to Investigate Needs of Engineering Education

Comprehensive plans for the promotion of research in engineering education and for the co-ordination of the various agencies interested in the subject have been reported to the Society for the Promotion of Engineering Education by its development committee. This committee, which consists of C. F. Scott, chairman, M. E. Cooley, J. H. Dunlap, D. C. Jackson and F. W. McNair, was appointed at the Urbana convention of the society last June to study and report on plans for development of its work.

RECOMMENDATIONS OF COMMITTEE

The full recommendations of the committee are as follows:

I. That there be created within the society a Board of Investigation and Co-ordination, consisting of five members, under whose general direction there shall be organized and conducted (*a*) an active campaign for the promotion of engineering education in light of the needs of the future as those needs may be developed; (*b*) there shall be co-ordinated as far as possible the activities of the various agencies interested in promoting engineering education; and (*c*) there shall be conducted research in engineering education.

II. That there be authorized a Board of Counsellors consisting of representatives from the several fields to which engineering education is related, to advise and assist the Board of Investigation and Co-ordination.

III. That there be authorized a director, with an adequate staff, the director to be appointed by the Board of Investigation and Co-ordination, and when appointed to be ex-officio chairman of the board, the secretary of the society to be ex-officio secretary of the board.

IV. That progress reports to the society be published periodically in *Engineering Education*, the bulletin of the society.

V. That President Charles F. Scott be a member of the board and have authority to appoint the other members; that the terms of the initial members be 5, 4, 3, 2 and 1 years respectively, the individual assignments being made by lot. That vacancies be filled by the council on nominations made by the board and that vacancies be created by the council upon recommendation of the board.

VI. That the objects (among others) for which the board is created shall be considered to be: (1) To ascertain the facts on engineering education, such as concerns (*a*) teachers, their origin, training, experience and effectiveness; (*b*) teaching facilities; (*c*) curriculums; (*d*) students and graduates, their origin, training, experience and effectiveness; (2) to ascertain present and future requirements in the fields served by engineer graduates; (3) to present the facts and requirements for their bearing on the training of the engineer to the end that he may (*a*) develop himself and his profession; (*b*) realize and fulfill his obligation to society; (4) to maintain close

contact with engineering schools enabling them to participate in the investigations; and reporting to them from time to time; to the end that the developments may be continuous from the initial contact between the colleges and the agencies of the board; and (5) to secure the necessary funds for these purposes.

The report is now before the council of the society which will act upon it by letter ballot.

To Hold Second Conference on Highway Education

The second national conference on education for highway engineering and highway transport will be held in Washington, D. C., Oct. 26-28, under the auspices of the Highway Education Board, of which John J. Tigert, U. S. commissioner of education, is chairman. The U. S. Bureau of Public Roads is co-operating in the arrangements for this meeting. It is desired to have present all state highway engineers, teachers of highway engineering and others who are concerned in the mutual problems to be studied.

The program will include papers and discussions of such topics as relation of highway transport facilities to national progress and national defense; the need of trained men in highway engineering; highway research; and the trend of engineering education.

There will be meetings of a number of committees and a symposium on highway educational problems.

Lynch Construction Co. Adds to Its Executive Staff

Plans for expanding the activities of the Lynch Construction Co., New York, to cover general heavy construction, have resulted in several recent additions to its executive personnel. Under the general direction of W. G. Lynch, president, and W. B. Gray, general manager, E. S. Closson has been added to the staff as construction manager, W. E. Giesen as chief estimator, and F. E. Ransome, as noted in last week's issue, as construction superintendent. The company was incorporated in 1918 and is the development of the Lynch Realty Co. which operated on industrial work for about sixteen years in the New England States.

Mr. Closson's experience includes general municipal and railroad work in New York State, six years on subway construction with the New York Transit Commission, town engineer of Montclair, N. J., for four years, consulting and contracting work and service on shipyard construction with the U. S. Shipping Board's Emergency Fleet Corporation. Beginning in 1919 Mr. Closson was chief engineer for the Lock Joint Pipe Co., Ampere, N. J., and last year served as general supervisor of bridges and structures for the New Jersey State Highway Department.

Mr. Giesen, a graduate of 1907 of the University of Texas, has had an extensive experience in estimating on construction work, following early service in the fields, railroads, irrigation, and building. He was chief estimator in 1917 for Stone & Webster in their southwest district. In 1919 he served as chief superstructure estimator for the Foundation Co., New York. During the war Mr. Giesen served in the Marine Corps.

Motor Vehicle Registration Shows Increase

Washington Correspondence

Highway transportation is steadily on the increase in the United States, as indicated by statistics of motor vehicle registration as of July 1, compiled by the Bureau of Public Roads of the Department of Agriculture. The registration of all types of motor vehicles, excepting motorcycles, on that date totaled 10,620,471, an increase of 157,176. This increase is considered to be a healthy growth as the first half of the year is regarded as the off-season for registration of new vehicles.

Motor trucks constitute by far the largest class in the increase, there being 116,701 new trucks, as compared with 35,030 passenger cars and 5,443 buses and taxicabs among the increased registration. The increase in the number of motor trucks as compared with Jan. 1, represents more than 16 per cent. The increase in buses and taxis is equivalent to nearly 11 per cent, as compared with the first of the year. Figures are not available to show what part of the increase in the bus and taxi registration is due to the increase in the number of buses traveling suburban and rural routes, but the bureau officials express the opinion that it is very probable that a considerable part of the increase is due to the development of this new form of transportation.

The statistics issued show a total registration on July 1 of 9,467,874 private passenger cars, 55,992 buses and taxis, and 1,096,605 trucks, making the total of 10,620,471.

The Bureau of Public Roads expresses the opinion that the great increase in the registration of commercial vehicles may be attributed largely to the present activity in highway construction, as motor trucks as a class have been more handicapped by a lack of good roads than have the pleasure vehicles.

Would Electrify Section of M., K. & T.

The Missouri, Kansas & Texas R.R. and the Texas Interurban Lines have entered into a 50-year contract for service from Dallas to Denton, a distance of thirty miles. The Hobson interests will electrify the M. K. & T. instead of building a second interurban line as called for in their contract with the city of Dallas. After some discussion this action has met with the approval of the city administration, and the offer was accepted Sept. 20. Progress now is contingent on the settlement of legal questions. The Texas Interurban interests are now building an interurban line to Terrell, thirty miles distant, which will be in operation by the first of the year.

Canada Turning to Oil for Heat

Because of the coal situation, furnaces in at least 200 buildings in Ottawa have been fitted with oil-burning appliances. As many of these buildings are large, it is estimated that nearly 6,000 tons of coal used last year will not be needed, or will be available for others. Reports from Toronto, Montreal and other large Canadian centers indicate that the sale of oil burners has increased considerably during the last few weeks.

Delay Decision on Current for I. C. R.R. Electrification

Decision as to whether the direct or alternating current system should be adopted in the electrification of the Chicago terminal lines of the Illinois Central R. R. has been delayed by the sudden death of A. S. Baldwin, vice-president in charge of this work. All the material collected by Mr. Baldwin for his report has now been turned over to D. J. Brumley, chief engineer of the Chicago terminal improvements, this work being handled by an organization independent of the regular engineering department of the railway.

Pacific Highway Paving Nears Completion in Washington

On the main north-and-south highway through western Washington, known as the Pacific Highway, with a length of 310 miles in that state, material stockpiles are being placed this winter for paving the remaining 37 miles which will complete a continuous line of paved roadway from the Oregon line to the international boundary. The contracts for this paving will be let early next year. The present plan is to let the work in seven contracts each covering a length of about 5 miles.

Preliminary Power Permit Sought for Ten Cheat River Projects

Washington Correspondence

Much significance is attached by the Federal Power Commission to the application of the West Virginia Power and Transmission Co. for a preliminary permit covering a comprehensive development of the entire Cheat River in West Virginia and Pennsylvania. This is one of the three streams which was considered by the government as a possible site for the government nitrate plant which afterwards was located at Muscle Shoals.

The applicant for this permit is understood to be closely allied with the West Penn Power Co., which has an extensive transmission system throughout the industrial territory tributary to Pittsburgh and Wheeling. It is the idea to develop all the available power on the Cheat River to interconnect with existing plants in the carrying out of a super-power project.

The company already has a permit from the War Department for a large development near the state line between Pennsylvania and West Virginia. It is now asking the Federal Power Commission for a permit to cover ten additional developments which will utilize all the fall of the Cheat River and practically all the reservoir sites along that stream.

The primary power available is estimated at 300,000 hp., but equipment capable of developing at least 500,000 hp. will be installed.

Additions to Industrial Film List

To the list of moving pictures of industrial operations, published in *Engineering News-Record* Aug. 24, 1922, p. 329, should be added "Getting Results on Road Jobs" and "Material-Handling by Machinery," which can be obtained for exhibition purposes by addressing James H. Gregory, The Barber-Greene Co., Aurora, Ill.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Convention, Cleveland, Ohio, Oct. 2-6.
AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Fall Meeting, San Francisco, Oct. 4-9.
AMERICAN PUBLIC HEALTH ASSOCIATION, New York; Annual Convention, Cleveland, Oct. 16-19.

The Houston Chapter of the A. A. E. has announced a fall program as follows: Oct. 11, "Half a Century of Engineering Achievement in Texas," L. A. Guerenger, engineer, Texas Railroad Commission; Oct. 25, "The Essentials of City Planning," Charles H. Wacker, chairman, Chicago Plan Commission; Nov. 15, "How Local Engineers May Aid the Houston Plan Commission," O. F. Holcomb, Mayor of Houston; Nov. 29, "Motor Truck Traffic on Highways: A Highway Builder's Views," Capt. J. D. Fauntleroy, Texas State Highway Engineer; and Dec. 13, "Motor Truck Traffic on Highways: A Railroad Executive's Views," Julius Kruttschnitt, chairman, Executive Committee of the Southern Pacific Lines.

PERSONAL NOTES

G. W. MAYO, highway engineer of U. S. Bureau of Public Roads, is acting district engineer District No. 6, Ft. Worth.

ED R. NEFF has severed his connection with the city of Jacksonville, Fla., where he was employed as assistant city engineer, to become county engineer of Bradford County, Fla. That county has recently initiated an extensive road-construction program, the cost being provided by a $550,000 bond issue.

MAJOR JOHN B. HAWLEY, consulting engineer of Ft. Worth, has been retained by the city council of Teague, Texas, for the purpose of investigating the enlargement of the water supply. The rapid growth of the town, with its consequent extension of the sewer system, as well as the large number of new connections, has proved that the supply received from the present wells is inadequate during the dry season.

HUGH M. HENTON, consulting engineer of Cleveland, Ohio, has arrived at Pullman, Wash., to succeed Prof. Chester G. Warfel, who died this summer, as assistant professor of mining and metallurgy in the Washington State College. Professor Henton has been connected with the Case School of Applied Science and with the South Dakota School of Mines, of which he is a graduate. He has been also director of research for the Aluminum Castings Co. of Cleveland and has at various times served as engineer for Western mining interests.

FRED H. FOWLER has resigned from the U. S. Forest Service to open an office as consulting engineer in the Humboldt Bank Bldg., San Francisco. He has been in the Forest Service for twelve years and since 1913 has been district engineer for California and southwestern Nevada with additional duties as representative of the Federal Power Commission covering extensive western territory.

MAYOR SAWNIE R. ALDREDGE of Dallas, Texas, and Major W. J. Powell, engineer to the supervisor, have left Dallas for New York City to consult Gen. Goethals in regard to a water supply for Dallas sufficient to take care of 500,000 population. Gen. Goethals recently made a report on the feasibility of creating a large lake adjacent to the business section of the city by providing a dam across the Trinity River.

ABEL WOLMAN was elected chief engineer of the Maryland State Department of Health on Sept. 21, to succeed ROBERT B. MORSE, resigned. Mr. Wolman will continue his activities as lecturer in sanitary engineering in the Johns Hopkins University School of Hygiene and Public Health and as editor of the *Journal* of the American Water Works Association.

ALEXANDER W. GRAHAM, former state highway engineer of Missouri, ALFRED T. BROWN, formerly with the Highway Culvert Co., St. Louis, Mo., and FRANK J. BEARD, formerly engineer of surveys and plans of the Missouri State Highway Department, have formed the Highway Equipment & Material Co., Jefferson City, Mo. The new organization will deal in highway equipment and supplies.

COL. C. H. CRAWFORD of Rio de Janeiro and CLIFFORD SHOEMAKER of Washington have been appointed official representatives of the American Association of Engineers at the International Engineering Congress at Rio de Janeiro this month.

COL. GEORGE M. HOFFMAN, Corps of Engineers, U. S. A., has recently succeeded COL. H. C. NEWCOMER as division engineer of the Gulf district with headquarters at New Orleans. He has just made his initial inspection trip over the Texas waterways. At one time Col. Hoffman was assistant engineer of the Galveston district.

OBITUARY

GUS CARLSON, a road contractor of Prairie City, Ore., was recently fatally injured while working on the John Day highway near Baker, Ore., when he was caught in the belt of a rock crusher. Mr. Carlson was widely known in the vicinity in which he was working, having been in the contracting business for a number of years.

CHARLES G. ARMSTRONG, consulting engineer, New York, died at his home in Jersey City, Sept. 11. He was 64 years old and was born in Senator, Ill. He was a graduate of the University of Illinois. Among his professional engagements was service as consulting mechanical engineer on the Singer Building in New York, where he maintained his offices.

From the Manufacturer's Point of View

Too Many Grades of Asphalt Specified, Say Producers

Engineer Co-operation Could Cut Varieties to 7 and Maintain Quality of Construction

PRODUCERS of asphalt for road and paving work believe that the multiplicity and non-uniformity of specification requirements for their material have reached a point which demands nation-wide co-operative action on the part of engineers, contractors, and producers to secure a reduction in the number of different grades of asphalt called for without in any way lowering the quality of construction involved. For construction ranging in type from asphalt macadam penetration to sheet asphalt pavement the producers believe that not more than 7 grades of material are ample, but under present conditions of non-uniformity in specification requirements more than 30 different grades are called for. This adds a host of complexities to the operation of oil refineries, not only in running the stills but also in the necessity of enlarged storage space for stocks of different grades. In the aggregate, therefore, the economic loss becomes large.

The chemistry of asphalt and tests to determine its quality constitute a highly technical problem that is understood by a comparatively small group of specialists. Highway and paving officials, without a full realization of the manufacturing problems involved, have been in the habit of basing their specifications on those used elsewhere for similiar work, injecting special requirements here and there to secure some supposedly special advantage in the product for their own work. The result has been the production of scores of specifications without correlation and with variations in demands which, the producers feel, while accomplishing no real good, hamper operations at the refineries.

REQUIREMENTS NOT UNIFORM

Another angle of the situation has been introduced by recent development of many state highway departments in the establishment of testing laboratories. While not objecting to the material-testing laboratory as a means of insuring the fulfillment of specification requirements, the asphalt producers have noted a tendency on the part of the laboratory personnel toward the introduction of new and special tests and refinements in specification demands carried to unjustifiable limits. With a wide variety of testing equipment available and a staff of technicians on the payroll conditions are created which lead to much individualism in the requirements of the 48 states. This phase of the situation has to do with demands intended to secure a product particularly adapted to local conditions of climate and traffic, all made in good faith, and does not involve cases where special requirements as to qualities of material or tests are introduced to favor a particular product.

The producer's problem would be

greatly simplified by more co-operation among the specification-producing bodies, such as the American Association of State Highway Officials, the American Society for Testing Materials, and the American Society for Municipal Improvements. The state highway officials, particularly, have indicated an attitude of aloofness, the producers feel, in excluding representation from the producing industries on their committees which draw up specifications. For identical purposes the states are now calling for a wide variety of asphalt grades and even in the same state periodic changes in specifications give the producer needless trouble. From the accompanying table containing merely a summary of certain state requirements for asphalt for asphaltic concrete pavement the amount of variation in specifications is apparent.

ILLUSTRATION OF VARIATION AND MULTIPLICITY OF STATE HIGHWAY SPECIFICATIONS FOR ASPHALT FOR ASPHALTIC CONCRETE PAVEMENT

State	Specific Gravity	Flash Point	Penetration	Loss at 325 Deg. F.	Penetration of Residue	Ductility	Melt. Point
New York	0.99+	375°+	50–65	4%—	50%+	25+	.....
	.....	.....	70–85	.....	.....	.....	.....
New Jersey	1.00+	347°+	50–60	1%—	25+	(c) 30+	.....
	1.02+	375°+	50–65	1.25%—	30+	(c) 50+	.....
	1.025+	392°+	55–65	1.5%—	35+	(c) 80+	.....
	1.03+	401°+	70–85	1.5–3.0%	40+	(c) 90+	.....
	1.035+	410°+	70–90	1.5–3.5%	45+	(c) 100+	.....
	1.04+	419°+	75–95	.....	.....	(c) 125+	.....
	1.045+	.....	.....	.....	.....	(c) 150+	.....
Delaware	.....	.....	(a) 40–60	3%—	50%+	(c) 30+	.....
	.....	.....	(a) 40–70	.....	.....	.....	.....
Pennsylvania	.....	.....	(b) 36–65	3%—	50%+	(c) 30+	.....
	.....	.....	(b) 40–65	.....	.....	.....	.....
	.....	.....	(b) 45–65	.....	.....	.....	.....
	.....	.....	80–120	.....	.....	.....	.....
Virginia and W. Va	1.01+	347°+	60– 70	1%—	30	.....	113°–131°
	1.05–1.07	.....	.....	3%—	40	.....	104°–140°
Ohio	1.01+	356°+	40–60	1%—	60%+	30+	.....
	1.05+	.....	.....	3%—	.....	50+	.....
North Carolina	1.00+	347°+	45–50	3%—	50%+	30+	.....
	.....	.....	50–60	.....	.....	.....	.....
South Carolina	1.03+	347°+	50–60	1%—	25+	.....	113°–131°
	1.05–1.07	.....	.....	3%—	30+	.....	104°–140°
Georgia	1.01+	347°+	50–60	1%—	30+	.....	113°–131°
	1.02+	.....	70–80	3%—	45+	.....	104°–122°
	1.05–1.07	.....	.....	.....	.....	.....	104°–140°

(a) Penetration to be varied within limits as directed by Engineer.
(b) Penetration to be varied within a 9-point range as directed by Engineer.
(c) Ductility at 50 penetration.
Note: The figures in the vertical columns are arranged merely to show variations in the particular requirement indicated by each heading; they have no relationship if read horizontally.

Eliminating factors of lesser importance the keynote test for asphalt quality is that of penetration and in any effort to secure greater uniformity in specifications the first effort should be directed toward a reasonable standardization of penetration limits. Many states fix a range of 10 points for a given grade; some of them use an even scale, from 50 to 60, for example, while others adopt odd scales, as 55 to 65. In some recent cases an 8-point or a 9-point range is specified. In other cases very wide limits of penetration are specified, with the notation that within this range the exact penetration will be set by the engineer. Such a requirement places the producer at a great disadvantage as he does not know what limits will be set by the engineer. A 10-point range in the penetration test for asphalts harder than 90 penetration, it is asserted, would result in the securing of a material entirely satisfactory from the construction standpoint and would greatly facilitate production. For asphalt softer than 90 penetration it is believed by producers that a 30-point range is sufficiently close for all practical purposes. The producers emphasize the fact that even in the highest types of asphaltic construction the asphalt itself constitutes 10 per cent or less of the materials employed, the other 90 per cent being made up of the fine and coarse aggregates. Practically all specifications for asphalt involve a degree of refinement which is not carried to the same limits in the case of sand or stone, with the result that no advantage is gained by super-refinements in the case of only one of several variables.

The seven grades of asphalt which the producers maintain could be substituted, without impairing the quality of road construction, for the 30 or more grades now demanded, would be made up of 3 different grades for asphaltic macadam penetration, and 4 grades for mixed asphaltic concrete and sheet asphalt. The penetration limits suggested for these grades are as follows:

Asphalt macadam	120-150 90-120 80- 90
Asphaltic concrete	60-70
Sheet asphalt	50-60 40-50 30-40

At the present time tentative specifications of the American Society for Testing Materials cover the same grades and would seem to offer a good working basis for co-operative standardization on the part of all producing and consuming interests, including the American Association of State Highway Officials. The A. S. T. M. tentative standards covering penetration limits are as follows:

Asphalt macadam	120-150 90-120 70- 90
Asphaltic concrete and sheet asphalt	60- 70 50- 60 40- 50

The manufacture of asphalt block is not considered in the foregoing.

While not as important as in the case of bituminous or sheet asphalt construction, the same need for uniformity as has been previously noted is desirable in the case of asphalt filler for brick or block pavements. Some progress has been made along this line through the efforts of the Asphalt Association, the American Society for Municipal Improvements, and the National Paving Brick Manufacturers Association. There remain, however, some variations in the ductility and melting-point requirements and some of the older specifications now in use are not suited to the changed condition caused by the employment of the squeeguee method of applying the filler to brick pavements instead of the hand pouring method formerly prevailing.

In the paving brick industry this year efforts to eliminate variety in sizes of brick resulted in a reduction of types from 66 to 11, with consequent savings in the manufacturing end of the business. The asphalt producers maintain that similar action aimed toward minimizing the number of asphalt grades called for would serve both their own interests and those of engineers, contractors, and the public.

BUSINESS NOTES

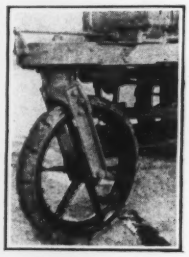
AUSTIN Y. HOY, manager of the London office of the Sullivan Machinery Co., has just arrived in this country to spend a month on business and personal matters.

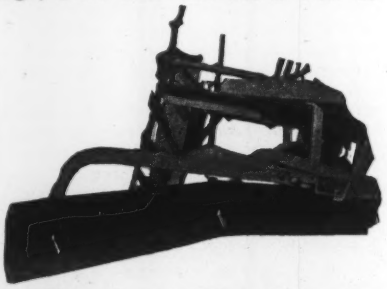
L. R. TILLOTSON, formerly chief engineer of the Road Supply and Metal Co., is now with the Barrett Co., having headquarters in Topeka, Kan.

EQUIPMENT AND MATERIALS

Road Grader Improvements

Several improvements to its one-man, power-lift "Road Razer," or road grader, are announced by the Avery Co., Peoria, Ill. The machine, designed primarily for road patrol and maintenance work, weighs 4,500 lb. and is mounted on three wheels to minimize turning space. Power is furnished by a six cylinder gasoline engine. The grading blade consists of three sections, two 5-ft. lengths and one 2½-ft. length, overlapping and hinged at the joints, so that it may be made to conform to the crown of the road. The blade, which cuts a 9 ft. 6-in. width, is 12 in. high, ¼ in. thick and has a 5-in. detachable and reversible cutting edge. By means of the power lift device the entire blade can be raised quickly and lowered when passing over obstructions, such as manholes, water pipes





and street crossings. Compression safety rings hold the blade down when the power lift is lowered. Roller bearings are provided for front and rear wheels.

Three types of lug equipment are provided for the rear wheels—angle cleats, spud cleats, and an extension rim with rectangular flat-bar cleats. Rubber-tired wheels are also provided.

Semi-Trailer Hauls 18-Ton Loads

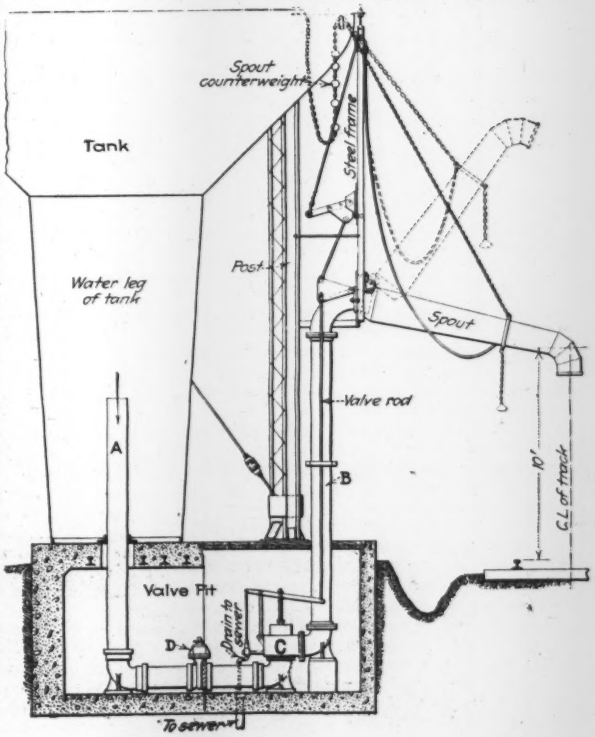
Designed to permit the use of heavy trucks under the Illinois state permissible 16,000-lb. axle loading is a semi-trailer recently put out by the Warner Manufacturing Co. for the use of the Consumers Co., Chicago. The Illinois

law permits an additional 12-ton total weight including load if a trailer with separate axle and separate set of wheels is used and as long as the limit of 800 lb. per inch width of tire is not exceeded. Experiments were started with a 10 to 12-ton vehicle but at the customers request the size was increased to a rated capacity of from 15 to 18 tons, permitted within the city.

Experiments made to determine the best methods of dumping the trailer led to transmission of the truck power through the fifth wheel of the semi-trailer into a hoist although a hydraulic hoist could be used. From the power take-off a sprocket and chain connects to the lower shaft of the transmission within a fifth wheel which operates through gears a splined shaft at the opposite end of which is another sprocket and chain driving the operating mechanism of the hoist.

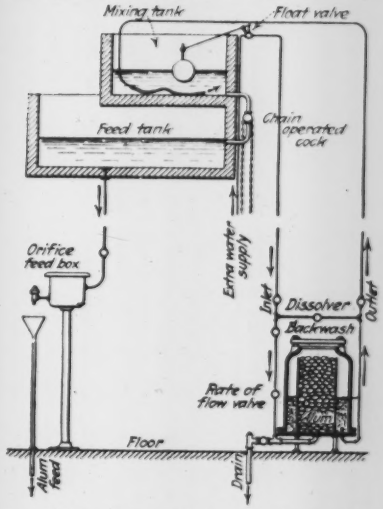
Non-Freezing Spout for Railway Tanks

In the Horton non-freezing spout for railway water tanks which has been put on the market recently by the Chicago Bridge & Iron Works, Chicago, the hinged spout is not connected directly to the tank but is mounted on a vertical pipe or water column which is normally empty. This water column rises from the valve pit and has its head supported by steel framing on the tank posts, as shown in the drawing. The outlet pipe *A*, standing in the water leg of the elevated tank, is connected to the water column *B*, by piping in which is placed a balanced valve *C*. Integral with this valve is an automatic drip-valve having pipe connection to a sewer or drain. When the spout is pulled down to the tender manhole it opens the balanced valve by means of rod and lever connections, thus opening communication with the tank. When the spout is raised it closes the valve *C*, but water trapped between this valve and the spout is drained off automatically by the drip-valve. A gate-valve, *D*, provides for shutting off the water to permit examination of the balanced valve. In experimental service last winter this tank spout arrangement is said to have given satisfactory results.



Alum Dissolved Under Pressure

A recently patented dissolver of chemicals under pressure for use in filter plants to eliminate pumping and mechanical stirring consists principally of a cast-iron cylindrical container having an inner and outer compartment and a hinged water-tight cover. The inner compartment is packed with alum; the outer is partially filled with coarse sand and gravel to filter the alum solution. Water under pressure rises through the alum and flows over into the annular filter compartment down through the gravel and is drawn off through a collecting ring under practically the same pressure as the original. The solution is lead to a mixing tank located at an elevation above the feed point. A float valve shuts off the supply at a predetermined point, all of the alum having been dissolved in the time taken to fill to this point. A nozzle on the end of the inlet to the mixing tank effects circulation.



Claims for convenience and cleanliness are made by the makers of the equipment, the Bannon Co., Toronto and Buffalo, since the dissolver can be placed near the storage bins and connected by lead piping to the mixing and feed tanks placed in any convenient elevated position, while the orifice box only need show in the head house or other point of application.

Out-of-the-Ordinary Trade Publications

Shellac—THE WILLIAM ZINSSER CO., INC., New York, tells "The Story of Shellac" in a 16-p. booklet. Contrary to popular opinion, the text states, shellac is not the gum or sap of a tree. Instead it is the hardened secretion of insects each about one-fortieth of an inch in length which swarm in great numbers on certain trees in India, commonly known as lac trees. Millions of the tiny red insects suck the tree sap up through their bodies and literally feed themselves to death. In passing through the insect's body the sap undergoes a chemical change and is exuded forming a hard, shell-like mass.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Why 1913 Is Used as Base by Bureau of Labor

It Represents Last Full Year Free from Unusual Disturbances, Although Conditions Were Not Normal

Does the fact that the Bureau of Labor Statistics uses the average of the year 1913 *as the base in its computations of percentages of price or wage changes in subsequent years mean that the Bureau regards* 1913 *as the normal toward which, commercially and industrially, we should strive?*

So many inquiries of this character have been received by the Bureau that Ethelbert Stewart, United States Commissioner of Labor Statistics, has issued a statement "to answer this criticism once and for all."

"Originally the 'base line' adopted by the Bureau," he says, "was the average for the 10-year period from 1890 to 1899 and this was used for a number of years. The reasons for changing this base line were that the figures for the earlier part of the decade 1890 to 1899 were not sufficiently comprehensive, that the more recent figures were much more satisfactory from every point of view, and that under ordinary conditions the base line should be a reasonably recent period, the old base line, 1890 to 1899, being looked upon as being too far in the past.

Ten-Year Base Line Dropped

"When this 10-year period base line was dropped, a plan was adopted of taking the average of the last completed year as the base line. The difficulty with this is that such an index does not give one a comparison over any desired stretch of time. It is desirable to have some standard not affected by present and intervening disturbing conditions when we want to know how this price or that wage rate compares with the price or the rate before the war, and the bureau has and will continue to compute its percentages and establish its indexes upon such a basis. From the beginning of the war, August, 1914, to the present time there has been no period uninfluenced by unusual conditions and which could be accepted as a base line. The year 1913 as a base gives only a sufficient backward look to cover all the essential requirements of an index. It gives one as the desired starting point the last full year free from unusual disturbances, but this must not be confused with our ideas or ideals of normal. In an address before the eighth annual convention of the Association of Governmental Labor Officials of the United States and Canada, I said:

"'The sooner we realize that the World War has made necessary a new world normal the sooner we will be able to arrive at a basis upon which economic conditions can be stabilized and a normal condition attuned to that basis may be reached. I am of the opinion that the phrase, "getting back to normal," is an unhappy and an unfortunate one, if by getting back to normal is meant the conditions in 1913. Personally I do not believe it is possible. * * * I am as desirous as anyone of reaching a normal, but I would reach forward and not backward for it. Before we can readjust to a new normal we must know what we mean by normal.'

"On several other occasions, both in public and in correspondence of the bureau, I have taken occasion to reiterate this position; and the fact that the bureau continues and probably will continue to use 1913 as equaling 100 does not mean that it considers 1913 as equaling normal. It is a false deduction to assume, because the statistician must have a definite base for his percentages and his index numbers, that therefore he considers that base as either fixed, normal, or relatively good. Wages were not fixed in 1913. They were going up and had been going up. Taken over a long stretch of years the increase in wages in the United States had been about 2 per cent a year up to 1913; and no statistician by taking the average for 1913 as his base line would think for a minute that he was thereby fixing a wage level. The same is true of prices. They have been going up for half a century, taking price levels as a whole.

"The Secretary of Labor, in a series of articles in the *Chicago Daily Tribune*, made it perfectly plain that the Department of Labor does not recognize the conditions of 1913 as being applicable to the present time nor as being a condition toward which we should strive.

"It is in the very nature of an index number that where the base is known, it can be shifted and a new index number formed on any other years as a base by the simplest mathematicl process; and for this reason and because it gives the situation from year to year over a considerable period and reaches back to a time before the present world disturbances began, this base line will be retained."

British to Use Unemployed on Drainage Work

(London Correspondence)

The British Ministry of Agriculture announces that, subject to the sanction of Parliament, funds will be available for carrying out drainage schemes for the alleviation of unemployment during the coming winter.

The Ministry, in the case of each scheme approved, will be prepared to advance the whole of the money required, subject to these conditions:

(1) All the work must be done as far as possible by hand labor; (2) seventy-five per cent of the labor must be ex-service men, if available; (3) of the remaining 25 per cent the majority must be married civilians, if available; (4) the wages payable for ordinary labor will be the agricultural rates for the district, as fixed by conciliation committees or otherwise; (5) all work must be completed by March 11, 1923, as no public money will be available after March 31, 1923; (6) on the conclusion of the work, a proportion of the net cost, up to 33⅓ per cent, will be refunded to the Ministry.

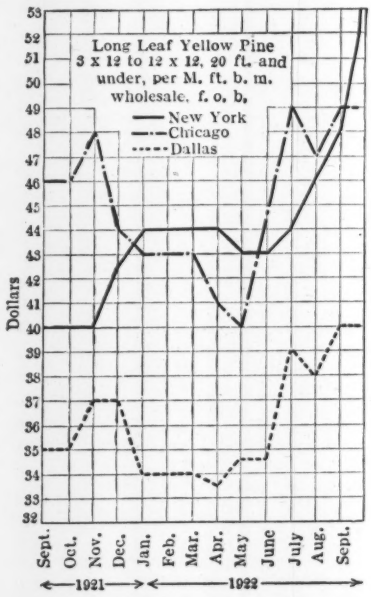
Runaway Lumber Market Not Likely

Prices Show Upward Trend—Production Increasing—Serious Car Shortage Checking Mill Shipments

A nation-wide survey just concluded by the National Lumber Manufacturers' Association to ascertain the possibilities of housing construction being retarded by possibility of a so-called "runaway" lumber market, has brought out the fact that large producers, dreading a feverish market and appreciating the menace to prosperity in a slowing-down of construction activities, are rushing production in order to avoid such a situation.

Reports received by the Association show that price increases on the whole have been small, since Jan. 1, the maximum being 23 per cent, at the sawmills.

Higher wages and other items of production costs and, in many instances, abnormal demand caused by excessive anticipatory buying, have accounted for most, if not all, of the price advances. In some instances, it is reported, manufacturers have sold lumber at a loss, at the sawmills.



The 375 mills reporting to the National Lumber Manufacturers' Association for the week ending Aug. 26, showed production at 236,485,952 ft. b.m,. or normal for that period; 357 mills reporting for the week of Sept. 2, showed production at 3 per cent below normal; while 354 mills in the week ending Sept. 9 reported production at 5 per cent below normal; latest reports as of Sept. 16, from 381 mills, show production at about 4½ per cent below normal, indicating a slight improvement in lumber output.

Orders have fallen off perceptibly, standing at 7½ per cent below normal on Aug. 26; at 15 per cent below, Sept. 2; 25 per cent below, Sept. 9 and 30 per cent below normal for the week ending

Sept. 16. Shipments have likewise dropped off, starting at a point 12 per cent below normal on Aug. 26, a slight gain of perhaps 1 per cent was realized for the week ending Sept. 2; the average dropped, however, to 20 per cent below for the week of Sept. 9 and stood at 23 per cent below normal for the week ending Sept. 16.

With a greater falling off in orders and shipments than in production, lumber stocks, throughout the country, do not approach a condition of depletion. A serious car shortage then looms up as the principal retarding factor in lumber deliveries from the mills.

With sufficient stocks available, held up by car shortage alone, the removal or alleviation of the latter emergency is calculated to exert a curbing effect upon the rising tendencies of the lumber market.

The accompanying chart illustrates the upward trend of pine prices in three of the most important pine-lumber markets of the country. Douglas fir prices have followed a similar upward tendency; in five out of nine cities, reporting weekly to *Engineering News-Record*, the demand for fir being heavier than for yellow pine.

1922 Expenditures on Southern Pacific System to Total $29,000,000

Extensive track work is included in the budget of $29,000,000 to cover construction and betterment on the Southern Pacific System in 1922 as announced in San Francisco on Aug. 23 by F. L. Burkhalter, assistant general manager, Southern Pacific Co.

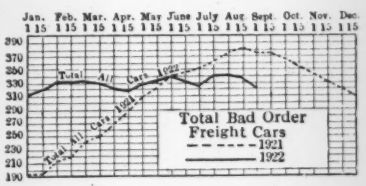
The program calls for an expenditure of approximately $11,300,000 for new rails, ties and ballast; $4,500,000 for new locomotives, $12,500,000 for new rolling stock, and $700.000 for plant facilities. It is estimated that 290 miles of track will be relaid with new 90-lb. rails; a total of 2,518,000 new cross-ties will be placed, and 800,000 cu.yd. of crushed rock and slag ballast will be used. Extensions to sidings at Crystal Lake, Cisco and Troy are being built to accommodate the long 55-car freight trains now being handled across the Sierra Nevada Mountains. The work of double-tracking the line across the Tehachapi Mountains will be continued this year in the portion between Bakersfield and Sivert and between Tehachapi and Cameron, a total distance of 23 miles. The enlarging, relining and concreting of tunnels will also be continued.

In addition to the construction program for 1922, it is announced that an order for $2,000,000 covering 45,240 gross tons of steel rails for use during 1923 has just been placed with the Tennessee Coal, Iron & Railroad Co.

Heaviest Car Demand Comes in Next Two Weeks

While 321,674 of the 2,270,551 freight cars on all lines were in bad order on Sept. 1, 1922, it must be borne in mind that one year ago 370,000 were out of commission. The chart shows the general movement last year and this.

With a falling off in surplus cars of over 35 per cent, during the week ending Sept. 8, also with 14 per cent of all cars, in need of repairs on Sept. 1, a critical situation presents itself as the railroads face the heaviest traffic period of the season, Sept. 30 to Oct. 15. An unusually large number of locomotives, in bad order, also add to the gravity of the situation.



An order issued by the Interstate Commerce Commission, effective Sept. 3, permitting the use of open-top cars, 42-in., or less in height, for shipment of commodities other than coal, released about 34,000 cars; a previous order affecting cars 36-in. in height, had released 62,000 open cars; these together with almost all surplus cars have since been absorbed by the volume of traffic normal to this season of the year.

Loadings in the last three weeks recorded are here compared with the same weeks in 1921 and 1922:

	1922	1921	1920
Sept. 9...	832,744	749,552	883,415
Sept. 2...	931,598	831,288	961,633
Aug. 26..	890,838	828,883	1,001,308
	2,655,180	2,409,723	2,846,356

Aside from a slight drop in car loadings during the week ending Sept. 9, the total for the week of Sept. 2 represented the largest week's loadings thus far in 1922. From the present time until the middle of October, railway facilities will be given a severe test in the handling of anticipated seasonal movements of grain, coal and general merchandise.

The American Locomotive Co. announces that during the ten days ending Sept. 20, orders were received for 176 new locomotives of various types. These engines together with other orders received in the same period, represent a total value of $13,250,000.

River and Harbor Bill Passed

Under the new arrangement of committees in Congress, a so-called legislative river and harbor bill has been brought out and has passed both the Senate and the House. The bill does not carry appropriations but simply authorizes the projects. The appropriations committees will recommend the amounts to be expended after receiving the estimates of the federal departments and conducting the usual hearings. In the Senate the following projects were added to the bill (survey): Westchester Creek, New York; Abescon Inlet, New Jersey; Inland waterway from Norfolk to Beaufort Inlet, North Carolina; Corpus Christi, Texas Harbor; Nogo River, California; Umpqua River, bar and entrance, Oregon; Siuslaw River, Oregon; Lake Washington ship canal, Washington; Tennessee Rivers and tributaries.

The Secretary of War is authorized in the bill to modify the East River, New York project and that of Wrangell Harbor, Alaska.

The Senate also added to the bill a provision that no project shall be considered by Congress with the idea of authorizing an improvement unless there has been a survey of the project within five years. With the idea of avoiding the delays and increased costs of the projects done on a piece-meal basis, the Senate inserted an amendment which authorizes the use of continuing contracts whenever such form of prosecuting the work may be prescribed in the bill carrying the appropriation.

Another Senate amendment to the bill makes it compulsory for carriers on the navigable waters of the United States to furnish such statements relative to vessels, passengers, freight and tonnage as may be required by the Secretary of War. The bill carries a penalty clause fixing a fine of $100 and imprisonment for each violation.

Where 18,299 Mi. of Federal-Aid Roads Were Built, and Types

Types of Federal-aid roads built in different sections of the country, vary largely according to availability of materials, volume of traffic and climatic conditions, as shown in reports of the Bureau of Public Roads, U. S. Department of Agriculture.

The 18,299 mi. of Federal-aid roads completed on July 31, have been distributed among the eight major types of construction, as follows: Graded and drained, 2,528 mi.; sand-clay, 2,222 mi.; gravel, 7,013 mi.; water-bound macadam, 456 mi.; bituminous macadam, 654 mi.; bituminous concrete, 699 mi.; concrete, 3,350 mi. and brick, 287 mi.

DISTRIBUTION OF VARIOUS TYPES OF FEDERAL-AID ROADS AND NUMBER OF MILES COMPLETED, JULY 31, 1922

State	—Miles Completed— Roads	Bridges	Grading and Draining	Water-bound Macadam	Bituminous Macadam	Bituminous Concrete	Concrete	Gravel	Brick	Sand-Clay
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	443.1	0.2	.....	18.7	154.4	66.3	73.8	129.9	.....	.....
New York, New Jersey, Pennsylvania	764.3	.....	.....	.....	23.6	77.1	637.5	3.4	22.7	.....
Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida	2,842.9	24.5	173.5	83.4	204.3	107.0	387.3	270.4	24.5	1,592.5
Kentucky, Tennessee, Alabama, Mississippi	1,046.0	1.1	221.9	46.4	78.7	31.0	34.2	416.6	10.3	206.9
Ohio, Indiana, Illinois, Michigan, Wisconsin	2,391.0	0.5	300.6	60.8	117.2	104.9	1,167.9	409.0	148.8	81.8
Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas	3,250.3	2.0	1,796.0	4.5	41.6	24.9	421.7	828.6	78.5	54.5
Arkansas, Louisiana, Oklahoma, Texas	2,795.8	5.9	118.8	186.8	51.5	197.4	113.2	2,081.8	2.0	44.3
Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada	2,659.5	5.0	726.4	29.6	1.4	34.5	217.8	1,407.8	.....	242.0
Washington, Oregon, California	1,125.2	2.3	248.4	25.6	.....	56.4	296.5	498.3	.....	.....

Oregon and Washington Have Extensive Road Programs

The road construction program of the Oregon state highway commission this year including uncompleted work carried over from last year will total $17,000,000 of which it is estimated that $13,000,000 will be completed this year. The entire 1922 program covers approximately 125 miles of pavement, 500 miles of broken stone or gravel surfacing and 400 miles of grading. This includes federal aid for 1922 on post roads amounting to $1,182,000 and government forest road funds for the state amounting to $1,157,000.

In Washington the work done this year by the state highway commission, including federal-aid funds, totals about $5,500,000. This is chiefly on main routes on which the grading has largely been completed in previous years. The total expenditures in Washington for the year are apportioned about as follows: grading, 16 per cent; surfacing, with crushed rock, 29 per cent; paving with concrete, 45 per cent; and bridges of more than 20-ft. spans, 10 per cent. The sources from which these funds are derived are about as follows: federal-aid, 14 per cent; taxation, 32 per cent; motor-vehicle licenses and gasoline tax, 54 per cent. About 90 per cent of the concrete paving now done in this state is 20 ft. wide or more.

The most important north and south route through Washington is the Pacific Highway, 310 miles long. Of this only 45 miles remains to be paved with concrete and most of this will be undertaken next year. A feature of road work in the western portion of Washington is the heavy cost of clearing the right of way. This varies from $100 to $800 per acre according to the stand of timber. The concrete paving standards on state work are for a minimum thickness of 6 in. at the edges and 7½ in. at the center, with a width of 20 ft. Where poor foundation is met, increased thickness up to 11 in. is used. Reinforcing is omitted only where the foundation is very good. Except in remote districts most of the Washington state highway work is contracted on the unit price basis.

The several counties of Washington are this year carrying on road construction programs estimated to total between $8,000,000 and $9,000,000.

A feature of Washington road work that has contributed to economy is the uniform specifications on sand and gravel which have been adopted by state, county and municipal authorities.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of September 7; the next, on October 5.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	$3.04	$3.65	$4.20	$2.92½	$3.05	$3.80	$3.25	$3.75	$3.75
Structural rivets, 100 lb	3.85	4.35	6.00	3.35	3.52½	4.80	+4.50	4.00	6.50
Reinforcing bars, ¾ in. up, 100 lb	2.94	3.50	3.50	2.82½	2.95	3.97½	3.00	3.75	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	57%	61.15%	45%	59½%	58.9-5%	43%	47.9%	45%	30.00
Cast-iron pipe, 6 in. and over, ton	55.30	49.00	51.50	46.86	52.00	60.00	51.00	+53.00	50.00
Concreting Material:									
Cement without bags, bbl	2.60@2.75	+2.54	2.25	2.20	2 39	2.85	2.71	2.90	2.78
Gravel, ¾ in., cu.yd	1.75	+2.00	2.25	2.00	1.75	1.75	2.25	1.00	1.50
Sand, cu.yd	1.00	+1.35	2.25	2.00	1.00	0.75	1.50	1.00	1.25
Crushed stone, ¾ in., cu.yd	1.75	1.90	1.65	1.60	2.25	3.50	2.25	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	+59.00	+42.00	40.00	49 00	40.00	50 00	33.00	24.50	50.00
Lime, finishing, hydrated, ton	15.80@16.17	23.00	25 00	18.00	29.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl	2.75@3.14½	1.80	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	18.00@20.20	12.00	10 90	11.00	18@19	12.00	15 00	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.0776	.115	.1101	.09	.065	....	.11	.08
Hollow partition tile 4x12x12, per block	.1112	.0776	.115	.0808	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal	.91	.99	1.13	.97	1.00	1.12	1.04	.86	1.12
Common Labor:									
Common labor, union, hour	.60	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.44@.60	.30	.25	.72½	.35@.50	.35@.50	.47½@.50	....	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81½c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par.) Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.

Changes Since Last Week

Structural shapes and reinforcing bars quoted at $2@$2.25, f.o.b. Pittsburgh; the lower figure applying generally on large orders, with smaller tonnages going at the higher quotation. Structural rivets quoted at $4.50 as against $4.25 per 100 lb., in San Francisco warehouses; discounts on black steel pipe, 2½-in., reduced to 47.9 per cent as compared with a maximum of 49.1 per cent, last week.

Stronger pig-iron market reflected in advance of $2 per ton in cast-iron pipe, in Seattle; prices firm in other cities, with slight scarcity of pipe.

Cement up 4c. per bbl. in Atlanta; New York quotations nominal, owing to keenness of competition. Cement may be had, however, at about $2.60@$2.75 per bbl., delivered, not including cost of bags.

Structural timbers, long-leaf yellow pine, up $2 per M. ft. in New York and Atlanta, following general upward trend due to car shortage.

Advance of ¼c. per lb. in red and white lead, f.o.b. New York.